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August - 1933

Controlling Maintenance Expenses By Locomotive Design

By H. J. Titus*

The control of maintenance expenses starts with the design of the locomotive. An accurate knowledge of these expenses offers the best solution to controlled maintenance. By no other method can accurate control ever be obtained

OF all the various expense items in connection with railroad operation, that of maintenance of equipment is of the first magnitude. The importance of this item is fully brought out by the records wherein this expense for Class I roads amounts to about one billion dollars annually, or 26 per cent of the total operating expense. Of this total maintenance of equipment expense that due to the maintaining of locomotives amounts to about four hundred million dollars annually. It is the largest single item in connection with the direct train operation expense, it being greater than the expenses of wages to train crews or the cost of fuel for train operation.

The importance of locomotive maintenance is even greater when measured by the cost of maintaining an individual class of locomotive, wherein with existing methods of operation and maintenance the average expense for a shopping period early in the life of a modern locomotive may vary from $20,000 to $35,000, representing from 20 to 35 per cent on the original investment. With the increasing age of this equipment it is possible that even a greater expense might be involved.

Because of the vast sums which are expended for maintaining locomotives, it is apparent that serious consideration must be given to the absolute control of these expenditures. To control these expenses it is necessary to go to the very foundation, that of locomotive design, before the locomotive is ever built. In this consideration of design, it is important that a thorough understanding be had of the variations which may be expected in the actual expense for maintaining locomotives and how these expenses are affected by variations in the design of the locomotive.

When a piece of equipment is required, it is not sufficient to consider only the capital expenditure which will be involved. It is also necessary to consider the various expenses which will go into the operation of the machine during its entire useful life. This is particularly true of locomotives, wherein the locomotive yielding the greatest benefits for the total money involved during its useful life should actually be the most acceptable piece of equipment. The capital investment in future locomotives may be greater or less than it has been in the past but the upkeep or maintenance expense should be the deciding factor, inasmuch as this factor will operate during the entire useful life of equipment, and in many cases will exceed several times the original investment in the equipment.

But if progress is to be made in the control of maintenance expense, it is essential to know just what these expenses have been in the past. The maintenance expenses of locomotives will vary with the use, power and possibly age of the locomotive, irrespective of the types employed. These expenses are usually given as the total cost per locomotive or the cost per locomotive mile. The average amount expended on Class I roads is about $6,600 per locomotive per year, or approximately 22½ cents per locomotive mile. Now, the total cost annually does not actually take into consideration either use or power. It is the average cost of all locomotives, irrespective of the type of work to which they are put. The cost per mile indirectly measures the use of a locomotive but does not take into consideration the power output of the locomotive. Obviously the expenses of maintenance as usually obtained are not of sufficient value for comparative purposes, let alone for predicting future expenses, as they do not measure all factors. This is emphasized when attempting to predict definitely the expense for maintaining a particular type of locomotive.

In some instances the total maintenance expenses have been separated as between different classes of locomotives. Under these conditions they are usually presented as the annual or monthly average for the particular class of locomotive. While these expenses would be far more

* Transportation engineer, Franklin Railway Supply Company.

valuable than the others previously mentioned, they would contain a time element which would have an adverse influence and in addition would be seriously affected by the shopping policies pursued on the particular road. In many instances these expenses will not actually reflect the true conditions for a given class of locomotive, the expense being either too high or too low, dependent almost entirely on the shopping policies adopted for the class of locomotive.

Under these conditions it is apparent that if progress is to be made through predicting the expense which will actually occur with a given class of locomotives before it is even built, then these expenses must be so obtained and presented as to give a true picture for particular conditions. The only real basis on which comparisons or predictions of maintenance expenses may be made is that which takes into consideration the individual locomotive for a shopping period. These expenses must include the classified, unclassified and running repairs. After obtaining the maintenance expenses of locomotives under these conditions, they may then be correlated with the use, power and age of the locomotive.

The modern locomotive in many ways now utilizes the principles found in central power stations. In the majority of locomotives, however, there is one great difference. The power units are not in principle similarly designed. In central station operation, one main unit is designed and operated to take care of the normal operating conditions while for the peak load requirements a supplementary unit would be available. With comparable conditions existing on a locomotive, the main cylinders should be so designed as to take care of the normal operating requirements while for the peak load conditions or the starting range of the locomotive, the booster is employed. The only fundamental basis which warrants such a design is the economy which can be produced from the operation. In view of the fact that the maintenance expense of locomotives depends upon use, power and age, it would appear if any economy results from such a design of locomotive that it will be reflected in the item of locomotive maintenance. These thoughts have led to studies of the effects produced on locomotive maintenance by the type of power when taking into consideration the locomotive booster. In these studies the maintenance of individual locomotives over a complete shopping period has been utilized as a starting point. From this a transposition is made to the average expense expected for a given amount of power and use.

The approach to the problem of motive-power maintenance is rather complicated as it must consider all possible types of repairs, all possible mileages which may be made between shopping periods, the various types or

Repair Costs For Locomotives Of One Class

Miles Between Shopping	Classified Repairs	Running Repairs	Unclassified Repairs	Total Maintenance Expense	Miles Between Shopping	Classified Repairs	Running Repairs	Unclassified Repairs	Total Maintenance Expense
65,034	$7,022	$3,359	....	$10,381	92,895	$7,525	$5,569	....	$13,094
65,166	5,927	3,913	$1,055	10,895	95,011	8,312	7,422	$1,426	17,160
66,448	9,638	8,095	....	17,733	97,962	4,981	8,719	....	13,700
67,795	7,688	3,979	....	11.667	101,069	7,781	4,507	1,147	13,435
68,920	5,788	4,178	936	10,902	16,279	3,566	1,513	....	5,079
69,151	5,267	4,569	342	10,178	22,199	2,612	2,959	601	6,172
69,387	6,416	3,361	....	9,777	24,347	6,701	1,379	....	8,080
70,441	5,103	2,905	....	8,008	26,724	3,956	4,940	....	8,896
70,699	7,223	5,236	....	12,459	27,537	2,945	3,146	....	6.091
71,765	8,171	5,392	....	13,563	30,682	3,089	1,998	....	5,087
72,112	6,333	2,724	....	9,057	31,937	6,132	2,090	....	8,222
72,225	5,672	4,114	....	9,786	34,870	6.250	2,345	....	8,595
72,534	6,757	3.715	....	10,472	37,835	6.066	3,334	....	9,400
73,174	6,360	3.696	....	10,056	42,023	6,099	4,092	....	10,191
74,457	6,617	3,411	....	10,028	43,519	4,620	3,306	....	7,926
75,001	11,696	4,374	....	16,070	45,158	3,934	2,557	....	7,491
75,204	6,530	2,498	....	9,028	46,315	5,402	3,764	....	9,166
75,821	6,823	5,518	1,577	13,918	47,232	5,583	3,594	....	9,177
76,128	5,394	4,491	....	9,885	52,980	2,692	3,355	144	6,391
76,417	5,942	5,139	....	11,081	53,363	4,735	3,232	508	8,475
77,158	6,111	5,960	....	12,071	30,707	4,917	2,103	....	7,020
77,442	6,693	7,028	....	13,721	31,372	6.127	2,737	....	8,864
80,042	6,161	3,802	....	9,963	32,437	6,095	2,064	....	8,159
80,320	12,946	5,172	....	18,118	34,244	6,001	2,716	....	8.717
80,647	5,904	4,709	2,298	12,911	38,389	8,751	3,007	....	11,758
80,940	5,918	4,777	....	10,695	40,598	4,816	3,306	....	8,122
81,842	5,240	8,797	1,767	15,804	42,277	5,309	3,203	....	8,512
82,814	5,324	4,701	....	10,025	44,605	5,498	3,847	....	9,345
83,859	5,988	5,300	....	11,288	44,910	5,288	3,815	....	9,103
83,971	5,238	3,292	....	8,530	45,129	7,624	4,165	....	11,789
84,113	7,249	5,258	....	12,507	45,184	4,949	3,567	....	8,516
84,259	8,552	5,063	....	13.615	45.260	5,460	3,206	....	8,666
86,351	7,018	4,976	....	11,994	46,730	4,784	4,690	....	9,474
86,876	4,525	3,944	....	8,469	48,740	4,545	3,960	....	8,505
87,044	5,436	4,607	....	10,043	49,930	7,203	4,331	....	11,534
87,277	6,230	8.745	....	14,975	56,318	5,193	4,208	....	9,401
87,299	7,145	5,822	....	12,967	41,419	5,331	3,304	....	8,635
87,806	5,739	4,903	....	10,642	44,271	4,403	3,629	....	8,032
87,864	7,368	3,529	....	10,897	45,068	5,704	2,616	....	8,320
87,913	6.139	5,218	....	11,357	45,645	6,114	3,690	....	9,804
88,363	6,659	7.864	1,610	16,133	46,566	4,968	2,379	....	7,347
89,113	9,612	7,307	....	16,919	47,547	4,964	3,124	....	8,088
89,815	6,547	4,688	1,394	12,629	51,102	4,702	3,325	568	8,595
90,699	6,341	7.437	....	13,778	51,242	6,301	4,943	....	11,244
91,029	5,031	6.051	....	11,082	51,702	4,277	3,029	1,632	8,938
91,239	7,609	7,482	....	15,091	52,213	4,207	2,901	....	7,108
91,874	8,841	5,153	....	13.994	53,302	6,076	1,955	....	8,031
95,086	6,490	6,375	....	12,865	54,179	4,441	2,747	....	7,188
30,970	5,534	3,776	1,419	10,729	54,478	6,688	2,041	....	8,729
58,527	7.588	4,056	1,471	13,115	54,621	6,384	3,870	....	10,254
59,763	11,252	3,972	330	15,554	56,383	5,228	3,234	....	8,462
73,033	5,704	2,726	....	8,430	61,459	3,750	1,521	....	5,271
76,058	7,207	7,073	....	14,280	51,893	5,932	2,395	....	8.327
77,920	6.450	3,797	150	10,537	52,593	9,064	3,858	....	12,922
79,446	5,624	2,119	....	7,743	53,350	5,138	5,604	....	10,742
80,863	6,824	3,824	....	10,648	54,270	5,021	2,765	....	7,786
82,365	5,617	6,472	....	12,089	55,375	6,236	3,433	....	9,669
83,464	9,304	3,635	....	12,939	55,528	6,726	3,178	....	9,904
83,615	6,343	4,406	....	10,749	56,356	4,939	2,757	....	7.696
84,915	9,384	7,557	....	16,941	56,724	4,063	2,542	....	6,605
86,220	5,701	4,975	....	10,676	57,263	4,973	2,688	....	7,661
86.914	5,351	4,251	....	9,602	57,395	5,182	1,750	....	6,932
87,321	5,607	3,942	....	9,549	57,703	6,395	3,428	....	9,823
89,333	5,422	8,755	....	14,177	57,991	6,031	3,668	....	9,699
89,454	5,321	7,961	....	13,282	59,049	4,833	2,604	....	7,437
90.314	8,154	3,793	....	11,947	62.300	7,724	3,152	....	10,876
90,729	7,655	5,137	1,203	13,995	62,808	6,691	4,406	....	11.097
92,372	6,804	4,569	....	11,373	64,436	6,430	1,993	2,226	10,649

classes of power, and the age of the power. In the table accompanying this article are shown a few of the observations which have been made on one particular class of power and from which some conclusions have been drawn. Originally the study was not confined to an investigation of the total cost of maintenance but took into consideration the running, classified and unclassified repairs, as well as the mileage for the given class of locomotive. The data were considered both from the standpoint of total cost as well as cost per mile. Studies were made to determine the relationship between the various costs on different bases and the mileage or use. These studies were extended to determine whether or not there was a relationship between the running and classified repairs under various conditions. The results of the various investigations showed that a relationship

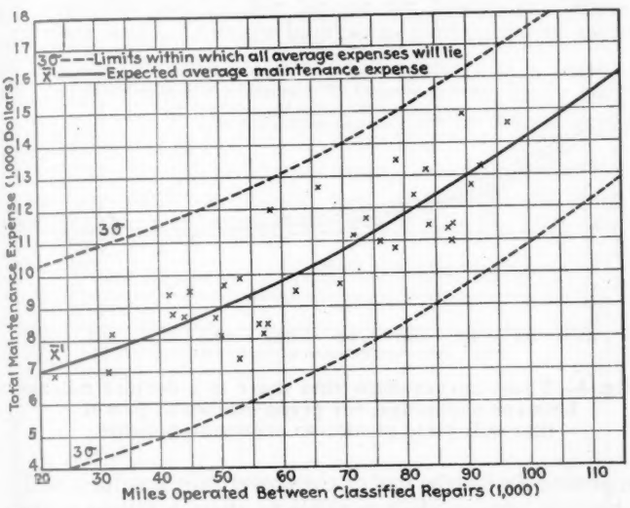

3σ---Limits within which all average expenses will lie
X̄'——Expected average maintenance expense
Total Maintenance Expense (1,000 Dollars)
Miles Operated Between Classified Repairs (1,000)

Fig. 1—Chart showing relation of maintenance expenditures to mileages between shopping periods

does exist between cost and mileage but that no definite relationship existed between the various costs. In other words, if the cost of classified repairs at some definite shopping is known, it is impossible therefrom to predict the running repairs in the ensuing period or in the preceding period. The converse will yield similar results. Obviously, it is impossible to predict unclassified repairs.

The results as to the relationship between total expense and mileage are not new. It is only reasonable and has long been known that the use of equipment will have a great bearing on the total maintenance expense. The more use that is made of a piece of equipment, the greater will be the total expenditure. This is fully brought out for one class of locomotive by Fig. 1, which graphically represents the data as given in the table. From this chart it is observed that the actual expenditure in dollars continually increases with an increased mileage between shopping periods. This is the usual experience with any piece of equipment wherein use is compared to the cost of maintaining the same. In this investigation interest did not lie in the expense of maintenance as the locomotive increased in age. Therefore, a definite age range was established within the limits of which the data were obtained. In this manner it was possible definitely to eliminate one variable which may have a great influence on locomotive maintenance.

In addition to the variables of use and age, there is also another variable which must be considered. This is the power of the particular type of locomotive. In Fig. 3 are shown the expenses for different mileages and for different locomotives. A decided difference in the expenses attributable to a difference in power will be noted. Usually this factor is not taken into account in considering locomotive maintenance except in a broad way, even though it has been known for many years that the greater the power of a locomotive, the greater the cost of maintenance. The next step in the investigation was to determine whether or not there was a definite relationship between maintenance expense, mileage between shopping and the power of the locomotive. To obtain this result the use of some reliable means for measuring the power is required.

There are several methods by which the power of the locomotive may be measured, one of the most convenient being the tractive force of the locomotive at a definite speed within the starting range. Another measure is the maximum indicated horsepower of the locomotive which occurs at some point in the operating range. These two methods of measuring power do not give the actual conditions. They only give the maximum conditions of which the locomotive is capable. Items reflecting power which will give the actual conditions for normal operation are the average drawbar pull and drawbar horsepower required over a given territory. It is impossible,

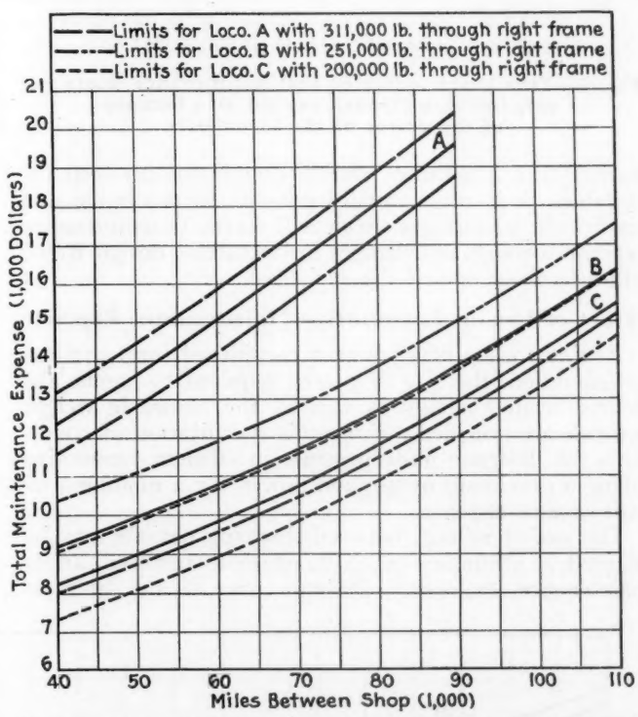

——Limits for Loco. A with 311,000 lb. through right frame
——Limits for Loco. B with 251,000 lb. through right frame
——Limits for Loco. C with 200,000 lb. through right frame
A
B
C
Total Maintenance Expense (1,000 Dollars)
Miles Between Shop (1,000)

Fig. 2—These curves indicate the variation in maintenance expense between locomotives of different power

however, to obtain these average results under the usual operating conditions. Another measure and perhaps one of the best which could be used to express power would be the average gross ton miles handled, but unfortunately, under the usual operating conditions, this is not recorded for individual locomotive operation. Other items expressing power, which might be valuable for a comparison of maintenance expense and can be made readily available, are the piston thrust and the forces exerted in the engine itself. All of these items are directly or indirectly a measurement of the power of a locomotive by which it should be possible to compare or determine the total maintenance expense for a given type of power, especially when usage is also considered. The method of measuring power finally selected for use in comparing maintenance expense should be the one most accessible and yielding the best correlation between the variables.

The best correlation between the three variables of use, power and maintenance expense occurred with the use of the forces exerted on the frames at the axle centers as the expression representing power. The average results obtained on this basis are presented in Fig. 3, from which it will be noted that the total cost of maintaining a locomotive not only increases through the use of the equipment but also because of the power. With actual data accumulated and presented in this

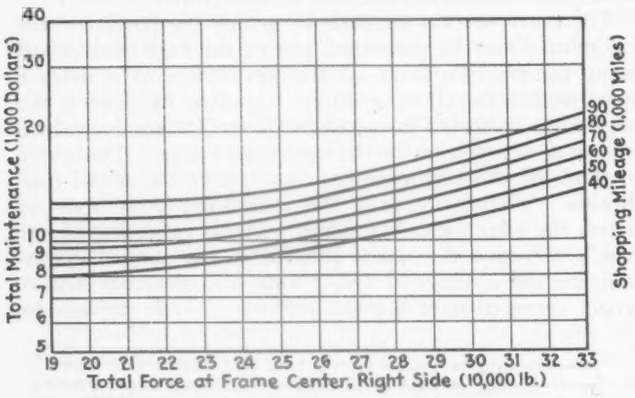


Fig. 3—This chart indicates that maintenance costs not only increase through use but also because of the power of the locomotive

manner and a definite relation established between the variables, it is now actually possible to determine and predict the advantages which will accrue to maintenance expense through any changes in locomotive design which will affect any one of the variables.

Effect of Use on Locomotive Maintenance Expense

At times when new power is considered for a particular operation, the size of power required to handle the desired train loadings as well as the allowable weight per axle are specified. From this specification of conditions the designer must produce an efficient locomotive giving a maximum of use and power for a minimum of maintenance expense.

The use or mileage between shopping periods may be effected in a number of ways, which in turn will affect maintenance expense. Perhaps one of the greatest effects will be produced through the shopping policies pursued. Other material effects can be produced through improvements in the design and the use of better materials in the locomotive. Examples such as the unit cast-steel engine bed, cast-steel tender frame, alloy-steel boilers, alloy rods, tandem main rods and improved materials in wearing parts all make for better use of equipment in that the total mileage between shoppings may be extended.

A typical example of these possibilities is had in the case of tandem rods wherein one road made application to existing power and made a direct comparison with ordinary rods. The engines with the tandem main rods required $.015 per mile less expenditure in materials and labor than the engines with ordinary rods. In addition to this actual saving in maintenance, it was found possible to extend the annual mileage and mileage between shopping by a substantial amount. Thus, through

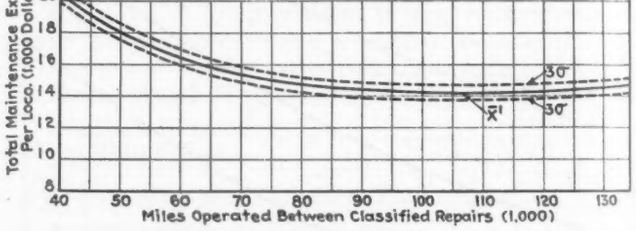

Average of 200 locomotives to be expected
Limits within which the averages from 200 locomotives will vary
Total Maintenance Expense Per Loco. (1,000 Dollars)
Miles Operated Between Classified Repairs (1,000)

Fig. 4—These curves show that there is a definite mileage between shoppings, for given classes of power, that will yield maximum economic benefits

improved design the use of the power unit was increased, which, in turn, made it possible to effect a saving in the maintenance expense.

The variation of maintenance expense with the use for one class of locomotive or where the power is constant may be made by the use of Fig. 3. These expenses are in total amounts, but if transferred to costs per 100,000 miles of operation, as in Fig. 4, it is possible definitely to assign the possible saving in maintenance through improved use of the locomotive. The data in Fig. 4 is for one of the classes of locomotives investi-

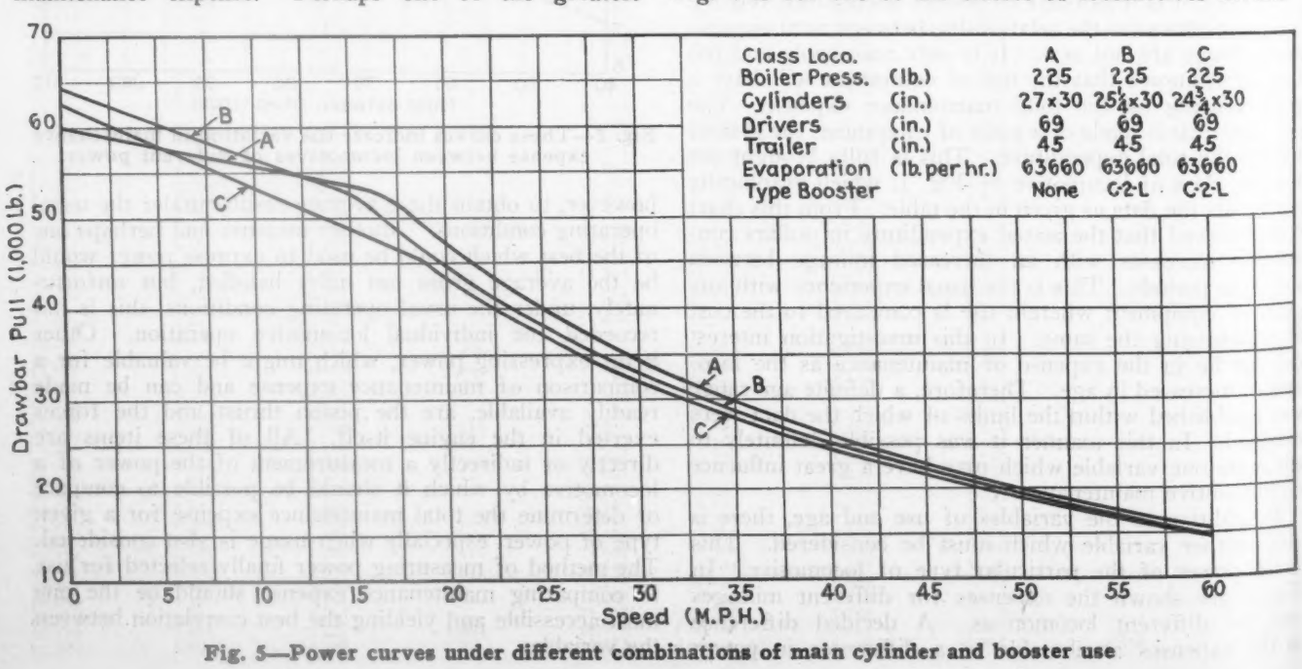

Class Loco. A B C
Boiler Press. (lb.) 225 225 225
Cylinders (in.) 27x30 25½x30 24¾x30
Drivers (in.) 69 69 69
Trailer (in.) 45 45 45
Evaporation (lb. per hr.) 63660 63660 63660
Type Booster None C-2-L C-2-L
Drawbar Pull (1,000 Lb.)
Speed (M.P.H.)

Fig. 5—Power curves under different combinations of main cylinder and booster use

gated and shows the characteristic curve. As the use is improved, the expenses will be reduced up to some definite amount of use at which a reversal in expenses will take place. Charting of the maintenance expenses in this manner makes it readily possible to ascertain the mileage between shopping, or use for a given class of locomotive, which will yield the maximum economic benefits.

Effect of Power on Locomotive Maintenance Expense

When the weight per axle of a locomotive is limited, the tractive force available in the starting range is limited either through the pressure permitted on the boiler or through the proportions of the cylinders or drivers. Any one of these factors can be altered by the designer, but there will be a proportionate change in the power unless other factors are changed proportionately so as to restore power. Thus, the piston thrust may be reduced either through a reduction in pressure or a reduction in the cylinder diameter. The resultant effect will be a reduction in the tractive force of the engine over the starting range.

With the weight per axle limited, it is possible to obtain the maximum power per locomotive unit only through the combination of main cylinder and the

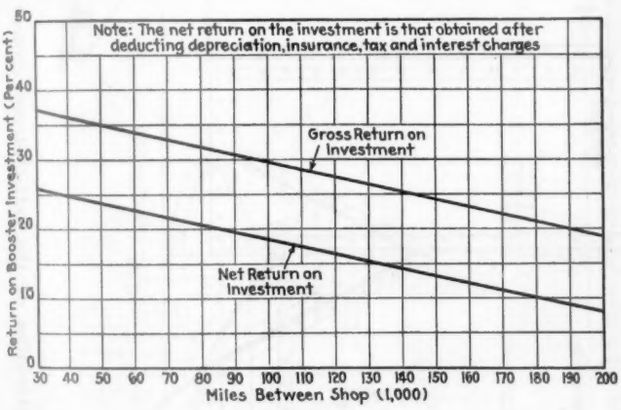

Note: The net return on the investment is that obtained after deducting depreciation, insurance, tax and interest charges
Gross Return on Investment
Net Return on Investment
Return on Booster Investment (Per cent)
0
10
20
30
40
50
30 40 50 60 70 80 90 100 110 120 130 140 150 160 170 180 190 200
Miles Between Shop (1,000)

Fig. 6—Return on booster investment from reduced maintenance expense by substituting booster for main cylinder power in the starting range

booster. If under the same limitations the train loads handled only require the maximum power which may be developed by the locomotive cylinders alone, then it is possible also to obtain this same power through a combination of the main cylinders and the booster. Obtaining the desired maximum power in this manner will obviously make it possible to reduce the piston thrust of the main cylinders as well as reduce the weight on drivers. Obviously, if there are no weight restrictions and it were possible to increase the number of drivers without limit, it would always be possible to obtain the same power from the main cylinders of the locomotive as could be obtained from a combination of main cylinders and booster. It is apparent that the same total power per locomotive unit may be obtained in either of two ways so long as the power is not limited by weight restrictions. In one case it will be obtained through a main cylinder and booster combination which bears a marked similarity in principle to central station practice and requires a minimum weight per locomotive. In the other instance, the maximum power would be obtained only through the main cylinders.

The operating range of a locomotive is defined as that portion wherein the power is dependent not only on the mean effective pressure, cylinder proportions and driver diameter but also on the capacity of the boiler to furnish steam. In this range the mean effective pressure is effected by the boiler capacity, the speed and the cylinder dimensions, and therefore a change in any one of these variables will produce a change in the power. A change in the boiler pressure will obviously produce a proportionate change in the power. Thus, if a locomotive is so designed to give a predetermined amount of power in the starting range by including the booster and reducing the piston thrust, then in the operating range there will be a reduction in power from that obtainable had the power in the starting range been obtained solely from the main cylinders. If the power in the starting range is derived from the main cylinder-booster combination, wherein main-cylinder piston thrust is reduced, it is possible to obtain the maximum power in the operating range for this combination by creating reduced piston thrust through a reduction in the cylinder diameter. In the operating range, the mean effective pressure under these conditions will be substantially greater than had the reduced piston thrust been obtained through a reduction in boiler pressure. In this manner it is possible in the operating range to obtain practically the same power for the locomotive irrespective of the method employed in obtaining the necessary power in the starting range. The selection as to the method of obtaining the desired power must take into consideration the economic benefits which may be derived.

Obviously, in the case of a booster-equipped locomotive there would be a possibility of saving weight on drivers, with a resultant reduction in the capital expenditure involved in the locomotive. This would be offset, of course, by the capital expenditure in the booster. The only other important source of possible savings to be derived by the selection of power can only arise from the maintenance expense, and, as brought out by Fig. 3, it is possible to realize a reduction in maintenance expense because of reduced power in the main cylinders of a locomotive.

Consider as an example a modern locomotive with which it is desired to obtain a minimum of expense. There are two possible ways of obtaining the power in the starting range, either of which are satisfactory under normal conditions, especially since the latest boosters are equipped with roller bearings and may be used for comparatively great distances at nominal speeds.

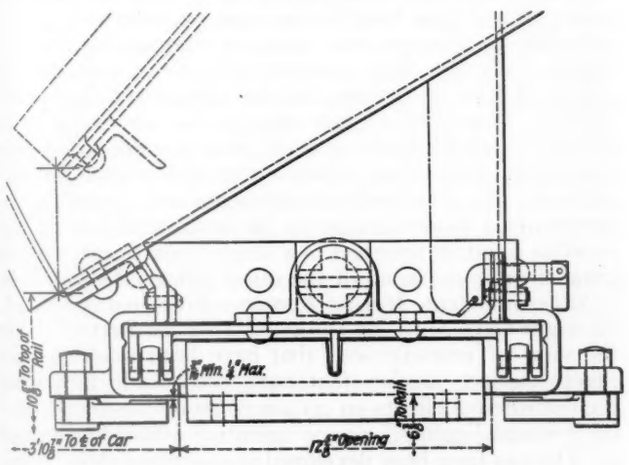
In Fig. 5 are presented the power curves to be obtained from this locomotive by the two methods. Curve "A" shows the power for the locomotive, which considers only the main cylinders for the production of power in both the starting and operating range. Curve "B" shows the power for both the starting and operating range when the main cylinders of the locomotive are so designed that in combination with the booster the power at 12½ m.p.h. is identical to the power of the locomotive as shown by curve "A." In this connection it will be noted that the power of the locomotive and booster combination exceeds that obtained from the main cylinders only at speeds under 12½ m.p.h. At 40 m.p.h., which is the usual operating speed, it will be observed that there is a reduction in power in curve "B" of 3.9 per cent. Curve "C" shows the power of the locomotive and booster combination with the power at 5 m.p.h. equal to that shown for the locomotive represented by curve "A." At 40 m.p.h. the power as shown by curve "C" is 5.8 per cent under the power as shown by curve "A." This loss in power in the last case would be equivalent to a reduction of 2 m.p.h. on a level track under identical conditions of loading. The relative advantage in obtaining the power of the locomotive in

(*Concluded on page 291*)

Plan and elevation of the self-clearing cement car

Lackawanna Develops Self-Clearing Hopper Car for Cement

ABOUT four years ago the Delaware, Lackawanna & Western started to develop a design of self-clearing hopper car which would be suitable for the transportation of bulk cement or other commodities of similar nature. After giving careful consideration to the various phases of this problem 10 existing hopper cars with 30-deg. slopes were converted for experimental purposes, and at that time all-steel roofs with hatchways were applied. As a result of this experiment it was found that it would be desirable to have a steeper discharge angle to the slope sheets in order to make them self-clearing. It developed that after a car was loaded with cement and moved over the road about 50 miles the cement would settle from 15 to 18 in. because of the air being forced out by the vibration of the car, thus making it very difficult to unload, as the cement would not run on the 30-deg. slope of the original sheets.

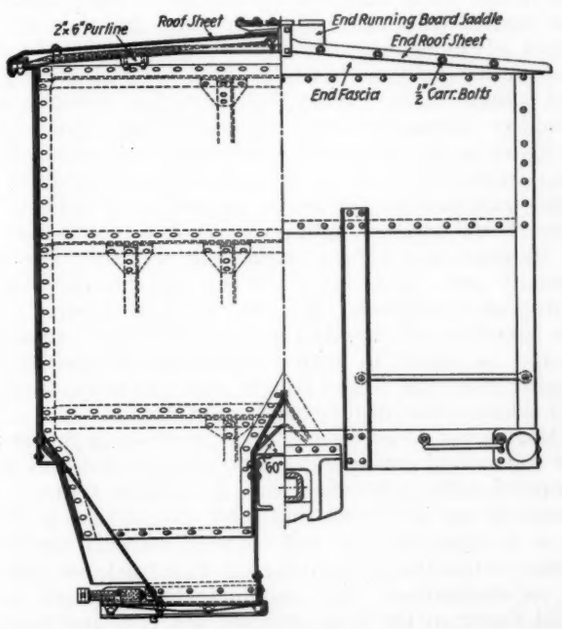


End view of hopper door

As a result of these findings it was decided to equip the cars with false slope sheets, cross-ridge sheets and longitudinal hood sheets on a 48-deg. angle, which has proved satisfactory from a standpoint of discharge through the door openings.

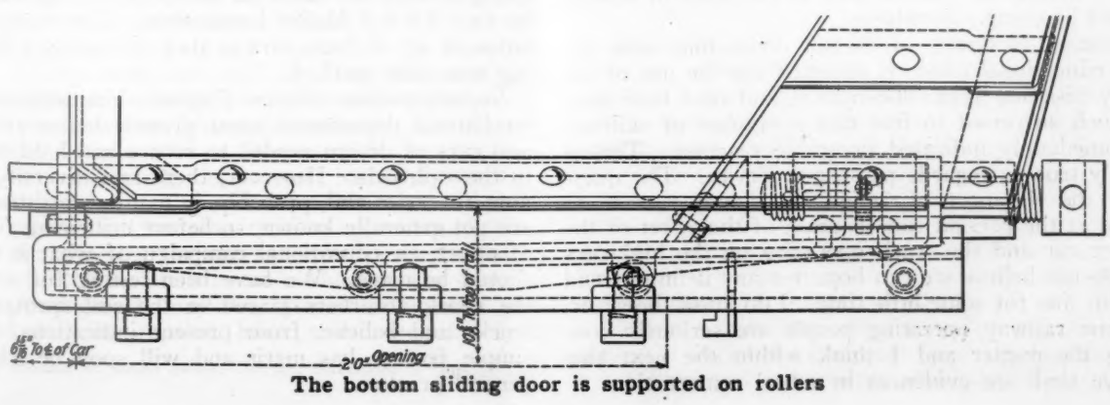
At the time the new false slope sheets were applied, a special design of bottom sliding door, developed by the D. L. & W., was applied. The sliding door is supported by eight rollers, four on each side, and is so constructed that when it is pulled out by means of a large screw, it drops away from the load, thus breaking the seal between the top surface of the door and the cement, after which the door can be easily pulled out to the desired opening. The four door frames are each provided with six swinging clamping lugs, three on each side, for applying canvas bootlegs to prevent the loss of cement dust while it is being discharged to a screw conveyor between the rails.

Since the original 10 cars were fitted up, the D. L. & W. has converted 115 additional cars to the design shown. By the use of these cars, bags are eliminated. Cement or other commodities can be loaded through hatchways in the roof and unloaded by means of the doors in the bottom of the car. This has proved satisfactory and has resulted in the economical handling of commodities.



Section and end elevation of car

During 1932 several hundred thousand barrels of bulk cement were handled in these cars by the D. L. & W., and an attempt is being made to find other commodities which can also be transported in this type of car.



The bottom sliding door is supported on rollers

Plan and elevation of the self-clearing cement car

More Reactions to R. T. O.'s Suggestions

CORRESPONDENCE continues to come in concerning the interview with the railway freight traffic officer which was published in the May issue of the *Railway Mechanical Engineer*. The high spots in the earlier letters were published in the June issue, and an article on the controversy by a car department officer appeared in the July number. A few of the outstanding comments, pro and con, received since that time follow.

Small Cars and Light Locomotives

Car Construction Engineer.—I do not want to throw stones at our friends of the railroads or criticize procedures with which I may not be thoroughly familiar, but it has often occurred to me, and I have discussed this matter with some of my friends, that the railroads might advantageously develop two types of freight service. A 100-car train is all very well for coal, steel, grain and similar bulk commodities, but for ordinary merchandise shipments requiring expeditious handling, it seems to me to be folly to employ big cars and make up long trains. If railroads do not want to lose all of the light merchandise shipments to trucks, I believe that they should employ light capacity cars, to be handled in frequent and high-speed freight service. The light capacity cars have stood the test of time in meeting European conditions. We are getting to a point where the practice of hand-to-mouth purchases seemingly should or ought to permit advantageous use of cars smaller than the 50-ton freight cars generally provided, and seldom filled in merchandise service.

Mechanical Department Officer.—It seems to me that the four-wheel car would not be a successful unit to be operated with eight-wheel cars in freight trains. The container car will meet this need, except that it should be so designed that you will not need a special unloading device to transfer it from the car to a truck for delivery to its destination. My recommendation would be to build fewer of the high capacity box cars and more of the low capacity. The weight of the car could be materially reduced and more cars per train hauled. I have often thought of the amount of punishment our old wooden frame cars stood and particularly as to the end shocks. An introduction of something of this character into our modern design to take care of the shocks would be a direction in which to work. It seems to me that if we incorporate such construction into the designs that we find today in our airplanes, where the shocks are distributed to and absorbed in the whole structure instead of concentrated at the point of attack, we would be going somewhere.

Equipment Designer.—I do not doubt that some intensive educational effort is required for the use of the specially designed lighter locomotive, and yet I have been very much surprised to find that a number of railroad men immediately indicated favorable reaction. This is especially true as regards passenger service. The question of the shipment of freight in lighter cars is so involved at the present time because of the effect of the container car and the truck operating on the highways that I do not believe we can hope for any definite trend along this line for some little time. I do know, however, that some railway operating people are seriously considering the matter and I think within the next two years we shall see evidences in actual construction.

Mechanical Superintendent.—So far as I know the car (four-wheel refrigerator) can only be operated on one railroad, the C. M. St. P. & P., and will not be accepted in interchange on any other railroad. The car has for some time past been standing idle at the Hormel plant in Austin, Minn. [It is true that the A. R. A. rules bar this car from general interchange. On the other hand, a considerable number of individual roads have agreed to take the car in interchange and the records show that it is in continuous use between Austin, Minn., and points south.]—Editor.

Mechanical Department Officer.—It seems to me that a subject has been opened up that should lead to a very helpful discussion, and I hope that you will manage to keep the ball rolling.

Easier Riding Freight Cars

Traffic Officer.—I thoroughly agree with the point of your editorial that freight cars must be improved so that we traffic people can relax some on our packing requirements. We can then compete with the trucks with a greater degree of success, for the shipper will be spared packing costs and freight charges on excessive dead weight of the packing. I think that you are to be congratulated upon your attitude that the mechanical department can give traffic departments and operating departments a better chance to be successful. It is impossible to attain progress in a single department without parallel progress in all of the other related departments.

Superintendent Motive Power.—Your editorial, "Freight Cars Must Be Designed To Ride Better," is, in the view of investigations that have been made, a very timely subject, studies that have been made indicating the detrimental effects on certain commodities on account of "vertical jiggling," as one operating officer has termed it. Devices have been developed to overcome these vibrations, and while the effectiveness of some of them remains to be proved by actual service, the means appear to be at hand, and I am satisfied that it is only on account of the financial situation on many railroads and private car lines that more applications of shock or vibration absorbers have not been made.

Railway Supply Sales Engineer.—In my opinion there is no question but that a different design of freight car is absolutely essential. Several days ago I happened to be standing alongside a railroad track in an eastern city as two freight trains passed—one with 52 cars and the other with 56 cars. I estimated that the trains were going at least 60 miles an hour. Each one was pulled by two 2-8-8-2 Mallet locomotives. The vertical oscillation in all of these cars as they passed over the crossing was quite marked.

Superintendent Motive Power.—Unquestionably the mechanical department must provide better riding cars and cars of design needed to secure and hold the traffic to the railroads. However, there is a diversity of cars now in service and, probably, in many cases, designs that are not generally known, so before criticizing for a lack of effort, an educational campaign of what is available should be made. We have been testing for some time the shock absorbers placed in the coil springs on car trucks and believe, from present indications, that this simple feature has merit and will soon be adopted in general practice.

Controlling the Cost of Locomotive Maintenance

By O. E. Ward*

Co-ordination of the effort of all employees is facilitated by figures from the accounting department showing current costs for labor and material, general repairs and running repairs on each locomotive

THE usual method of computing locomotive maintenance cost is on a mileage basis and this seems to be as equitable a basis as can be used as between divisions of a railroad. Costs on a mileage basis are not always comparable as between railroads, due to the different policies of making charges to locomotive maintenance costs, both labor and material. Some roads charge scrap value, plus the cost of conditioning for repaired materials, while others credit needing repair material at 80 per cent of the new value, and charge it out at new value after reconditioning. There are different sizes of locomotives to be considered, but the general average is about the same. Costs arrived at on a tractive force basis, or a ton-mile per train-hour basis are all right where close calculations for the management are needed, but the average employee will take more interest in, and get more information out of a statement made up on a mileage basis—and by "employee" I mean the workman and his immediate supervision. If locomotive maintenance costs are to be kept to the minimum, without loss of efficiency or a lowering of the general condition of the power, every man from the chief mechanical officer down to the workman who actually makes the repairs must co-operate to that end. The supervision must know exactly what material and labor costs are, and the workman should be informed regarding the value of the material he is using. He will then usually co-operate to the fullest extent in conserving it.

It is, of course, necessary that certain machinery be set up to secure, assemble and distribute this information, which is done as follows on the Chicago, Burlington & Quincy:

(1) The accounting department has established at each of the general shops an accounting organization to keep us informed currently as to the amount of money spent for labor and material on each locomotive in the shop. This information is available to the shop superintendent any day, on any engine, should he ask for it. Four times a month a statement is handed him, showing just how much has been spent so far on each engine in his shop. This gives him a chance to check his expenditures against the progress that has been made in repairing the engine. Should cost appear to be running out of line, he can take immediate action to control it. A copy of this statement also goes to each supervisor in the shop, and a copy is sent to the superintendent of motive power. Two days after the engine is released from the shop, a statement is issued showing the actual cost of repairs, divided as between labor and material, and with shop and store per cents added. This statement also shows the cost of repairs to the last four engines of the same class and receiving the same class of repairs, also an average cost of the five engines mentioned. Any increase above the average cost is fully investigated.

(2) The accounting department issues a statement each month showing the costs for labor and material, general repairs and running repairs, on each individual engine, also showing the average cost for each class of engine. A recapitulation is made showing the costs by divisions and grand divisions, divided as between general and running repairs, labor and material. Each master mechanic gets a copy of the recapitulation and the individual costs of engines on his assignment. We find these statements arouse keen interest among the supervision in the shops and roundhouses, and has had a decided effect in bringing about the introduction of new methods in handling the work, and particularly in bringing about a close check on damaged or worn material as to whether it should be repaired or new parts used.

We find a greater effort on the part of supervision to centralize the work in special gangs, and in each case much greater efficiency results. For instance, by rearranging and centralizing the work in the rod gang, a saving of 60 per cent in man-hours was accomplished. In the shoe-and-wedge gang, a 55-per cent saving resulted. This gang was also provided with a small drill, which allowed them to do their own drilling. In the valve gang, a saving of 55 per cent in man-hours was accomplished.

There are also other cases where we found it possible to relocate machinery for the specializing of gangs, particularly in handling boiler and flue work in the machine shop, which brought about reductions in cost. Numerous jigs, special chucks, mandrels, etc., have been developed to reduce the time for different jobs.

Time Schedules for Detail Operations

All operations in all departments of the general shops have a scheduled time in which the work is to be performed. In general, all of the time studies are made by the shop supervision; however, before being made effective, they are checked and approved by system production supervisors. The checking of the daily production time of workmen is done by the local supervision in the shops. If a workman completes a job in less than the scheduled time, he accumulates bonus time, which is paid for at his regular hourly rate. Should he fail to make the production rate, the reason for it is ascertained. This is very important as rate failures have been the means of calling attention to castings that are too hard, or castings, or forgings, on which too much material had to be machined off. By correcting the patterns, we not only saved machining off the surplus material, but also reduced the weight and the cost of the castings or forgings.

Generally speaking, the longer an engine is in the shop, the higher the cost, and with this thought in mind, a routing sheet is prepared weekly with all engines in

* Superintendent of motive power, Chicago, Burlington & Quincy, Lines East.

shop listed with date in, date for boiler test and other items such as frames, cylinders, guides and crossheads ready, guides and crossheads up, valve motion, spring rigging, shoes and wedges, driving boxes, engine wheeled, tank ready and engine out of shop ready to fire with respective dates on each item. All dates are based on boiler test and each item must be ready on time or delay will result.

In recent years, some of our shop practices have been changed. Formerly, an engine arriving at the shop for general repairs was completely dismantled, regardless of conditions. Now we take down only such parts as are in need of repairs. For instance, if the guides are in good shape, they are not taken down. As an illustration, when a master mechanic receives authority to move an engine to the shop, he advises the shop as to the condition of the back cylinder heads. If reported good, the shops may not find it necessary to take them down. The savings on one engine may be small, but will amount to a considerable sum in a year's time.

We are now welding in switch engine flues without ferrules at a saving of about $25 to $30 per engine.

Methods of Reducing Costs at Engine Terminals

Reports are made up monthly, showing for each engine, the total mileage made since the last general shopping, enginehouse cost since last general shopping and the months of service that can be expected from each locomotive. This cost statement again has its influence. It is gratifying to note the effort the engine foreman will make to control individual engine costs. With any easing up of power requirements, he will at once set the surplus locomotives aside to avoid the expense of the monthly inspection and also get credit for months out of service so that the life of the flues can be prolonged. Or, if the cost to maintain the machinery is out of line with mileage that has been made, he will, if possible, assign the engine to service that will prolong its service in order to bring the cost in line.

Water conditions have a decided bearing on locomotive costs, and for that reason, practically all of the important water stations are provided with lime-soda-ash treatment, and are closely supervised by the water engineer and his field men, who make frequent checks of the quality of the water supply. This has materially lengthened the life of the flues and quite often we find an engine that has 48 months of service on the flues as permitted under the federal rules, and the machinery is still in good shape, or can be made so with light repairs. In such cases, we ask the chief federal locomotive inspector for an extension on the flues; he has been very willing to grant these extensions when the conditions justified it, and this has been a great factor in controlling the locomotive costs.

Portable gas- or electric-driven crane trucks are used in practically all enginehouses where maintenance work is handled. They are invaluable in handling air pumps, feedwater pumps, tube bundles for feedwater heaters, rods or other heavy parts, and usually on these operations will reduce the labor cost about 50 per cent. A check of the cost of stripping a heavy 2-10-4 locomotive and delivering the parts to the machine shop developed a cost of $52.98 when done with the crane, as against $96.75 when done without it, and the hazards of handling heavy material are practically eliminated by their use.

As a result of closing a number of smaller terminals, and concentrating the work at larger ones, we have been able to install labor-saving devices, such as locomotive hoists, drop-pit tables, overhead cranes, etc., at the latter places and largely eliminate physical labor in handling heavy parts. The best tools have been assembled at these places, which not only expedites the work, but enables us to make permanent repairs and prolong the service life of the engine.

The enginehouse foreman is encouraged to call attention to facilities that will result in enabling him to expedite his work.

Satisfactory Materials Must Be Secured

The question of proper materials is ever with us and we are constantly in touch with the laboratory on it. Good materials are, of course, essential, but that does not mean that the higher-priced materials are always the most economical to use. We recently changed the composition of our driving-box brasses from phosphor bronze to high-lead bronze, and we find that we are getting decidedly more mileage out of our high-lead bearings than from the phosphor bronze ones, and the cost per pound is less for the high-lead. Another recent check developed that a cheaper welding material could be used on ashpan work, which will result in a saving, and the results are just as good; of course, the better materials will be used in boiler work, frame welds and other important jobs.

Too much cannot be said of the necessity for, and results accomplished by, a rigid inspection at the time of the monthly test. In addition to the federal tests required, we also test the steam pipes and superheater coils, remove side-rod collars and examine rod bushings, and on the more important power, the valves are pulled and examined, cylinder packing examined and everything done to eliminate, so far as possible, the necessity for handling any heavy items until the next monthly test.

In checking shop and enginehouse operations, we found that considerable time was lost by mechanics and helpers going for material. We, therefore, arranged for the stores department to deliver all material to the point at which it was to be used. This was accomplished by having the stores department men make regular trips through the shop or roundhouse to collect the orders and deliver the material. At the larger terminals, these men are provided with Clark tractors. Delivery men with these machines can make several deliveries during the time it would take a mechanic to go for his material. This keeps the mechanic strictly on mechanic's work, no excuses being accepted for the mechanic's going for material. If he is delayed for anything, there is something wrong with the system; we look for that fault and correct it. We may not have made our needs known in time to let the delivery man get it to us, or the system may not be perfectly organized; at any rate, the mechanic stays on the job—he would not be served by the store if he went there. These delivery men also handle intershop messages in the general shops. This saves the supervision considerable time and keeps them with their gangs. The delivery system requires a little closer attention in the roundhouses, until we get the mechanics educated to the fact that the first thing to be done when assigned to a job is to check it for the material he may need. There is an indicator in front of each engine, and when set in "Need Material" position, it becomes the duty of the delivery man to get in touch with the mechanic in the cab, in the pit, or at the rear of the tender. There must be no delay to the mechanic.

Extension of Locomotive Runs Reduces Costs

Extended locomotive runs have been a great factor in bringing down locomotive maintenance costs; it reduces the number of locomotives in service, consequently the number to be repaired; it is decidedly beneficial to the boiler as we do not have the continual raising and

(*Continued on page 289*)

Railway Shops Badly In Need of New Tools*

Radical changes in conditions and marked improvements in machine tools justify replacements on large scale

FREIGHT-CAR loadings have been increasing at a steady and rapid rate for many weeks. Electric power production, another good business barometer, has paralleled the improvement in freight car loadings. The railroads are carrying a goodly share of the unexpectedly large number of visitors to the Century of Progress Exposition at Chicago. The farmer is getting a higher price for his products, thus making it possible for him to buy more freely.

Railroad net earnings have been increasing and many of the railroads are now enlarging their maintenance programs and, in particular, are speeding up their repair shop operations. Fear is expressed in some quarters that car shortages are impending and that the freight traffic congestions of ten years and more ago may return with a vengeance. Are the repair shop facilities ample to take care of the demands that will be made upon them? Is there a need for new tools and equipment?

To secure an authoritative answer to these questions I searched out a mechanical department officer who has made good in a decided manner. Moreover, he takes a keen interest in the repair shop facilities and operations, never losing an opportunity to visit shops (railroad and industrial) to secure suggestions for further improving the efficiency and effectiveness of his own operations.

He was working under pressure when I approached him, but dropped everything for the moment to give me his undivided attention. I lost no time in getting down to brass tacks.

"You have given a lot of attention to your repair shop facilities in recent years," I said. "Before the depression you were in the habit of regularly adding new tools to your equipment each year. You should be in an excellent position from the standpoint of efficiency, except that, of course, there has been some deterioration in your equipment in the past two years. Presumably, for instance, some of the small tools have worn out and have not been replaced. What are the first things that you are preparing to buy, now that business is picking up?"

His answer came as quick as a flash. "As soon as I can get them budgeted," he replied, "I want to install a considerable number of modern, up-to-the-minute machine tools." (In confidence he mentioned the number. It was so large—at least it seemed so to me—that I gasped.)

I was surprised, for I expected him to say that his equipment was in such shape that he could get along without buying any large tools at present, but that he would have to bring the smaller tools and equipment up to normal as quickly as possible. He did admit that this was necessary, but continued to place special emphasis upon the need for up-to-date machine tool equipment.

"Just why is this so necessary?" I asked.

"For several reasons," replied S. M. P. "In the first place, as you very well know, there has been a tendency in recent years to concentrate repairs at central points and to close down the smaller shops. This centralization has made it possible to organize much of the work on a production basis, even though the number of parts involved in a locomotive repair shop, for instance, is very small as compared to average industrial operations. The concentration of repairs in this way makes possible the use of more highly specialized machine tools. We had a very large number of new machine tools budgeted when business slowed down, but since that time we have gone ahead with the centralization of our repairs and the need for the new tools is even more imperative now than it was a couple of years ago."

"You must remember, also," continued S. M. P., "that radical changes have taken place in machine tool design and operation in recent years. You may laugh when I tell you that one of the first things that I would do if I had the money would be to buy a number of new drill presses. Such great improvements have been made in the drilling machines and in the drills themselves that it is now possible to drill a 2½-in. diameter hole in the same time that it requires one of the older machines to drill a 1-in. hole. Then, too, as you very well know, some of the older types of standard machines may now be replaced to excellent advantage by milling machines, grinding machines and other special types. If we had the money to spend, I am sure that I could add a large number of new tools to excellent advantage and guarantee a saving of 20 per cent."

"I can't understand," I said, "why you are so emphatic in your statements. Did you feel the same way two years ago?"

"Yes, I felt much the same way then," replied S. M. P., "but I could not press the management as hard as I now feel I can do when more money becomes available for maintenance purposes. You may recall that for several years we were busy extending locomotive runs and introducing larger and more efficient power. To use such locomotives to advantage it was necessary to make heavy expenditures for enlarging turntables, improving enginehouse equipment, and strengthening track and bridges. The time has now come, however, when I believe we will find that the best investment we can make will be in improving our repair and maintenance facilities. I am all the more impressed with this fact as I find opportunities to study the greatly improved tools and equipment which are now available, many of them specially designed for railway purposes."

* The second of a series of interviews on mechanical department problems with men in that department.

RELICS IN A WALL.—Seven passes, issued in 1882 and good for transportation on the old Oregon Railway & Navigation Company, were found when a wall in an old building at Portland, Ore., was torn down. Along with the passes were a cancelled check for $48.50 and a book of rules and regulations in force on the railroad at that time. One of the most interesting rules was the one governing the speed of trains. Under this regulation, no passenger train was permitted to exceed a speed of 18 miles an hour, and freight trains were restricted to a maximum of 13 miles an hour. This, of course, was before the days of 40-mile-an-hour competitive motor trucks.

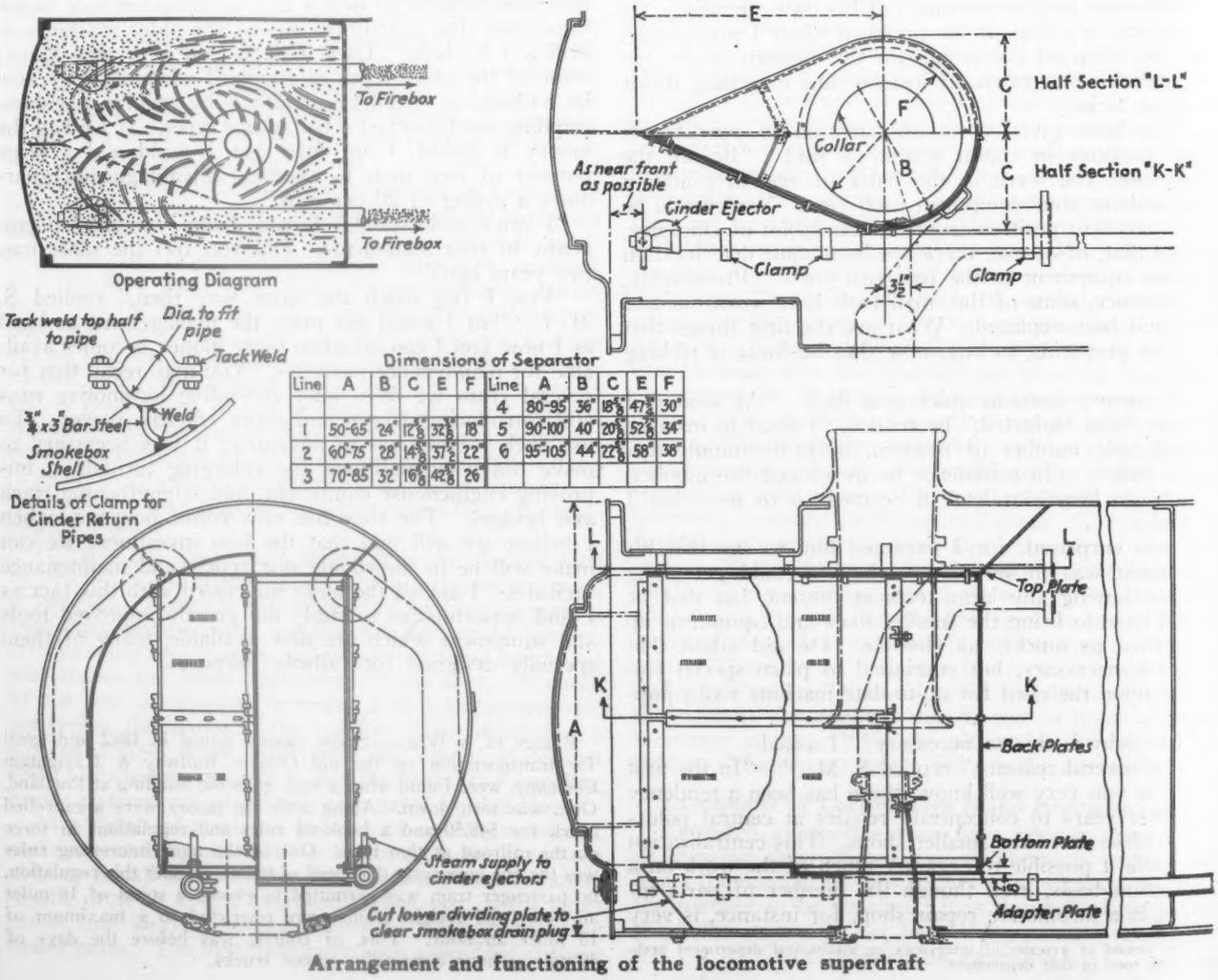
Draft Appliance Returns Cinders to the Firebox

The superdraft prevents cinders from passing out the stack and requires no diaphragm plates, thus reducing the resistance to the flow of gases. Ejectors return the cinders from the smokebox to the fire bed

A LOCOMOTIVE front-end arrangement which is designed to retain all cinders in the front end and return them to the firebox for complete combustion has been developed by the J. S. Coffin, Jr., Company, Englewood, N. J. The equipment, which is known as the Superdraft, consists of a separator, through which the front-end gases pass freely to the stack and from which the cinders are diverted by their own inertia, and two steam ejectors by which the cinders are picked up from the bottom of the smokebox and returned to the firebox through return pipes which pass back through the barrel of the boiler.

The separator replaces all baffle plates and netting as customarily employed in the locomotive front end. It is built-up of top and bottom plates and a frame of light vertical members to which solid and perforated plates are attached by the customary key-bolt fasteners. The top plate is suspended from the top of the locomotive front end, and a tight closure about the extension stack is effected by means of a collar which is key-bolted in place. The nozzle extends up through the bottom plate, which is supported from the bottom of the front end by means of a sleeve which surrounds the nozzle base and by a vertical dividing plate which extends forward on the longitudinal center line of the front end, to which it is attached by welding. The enclosure of the separator back of the center line of the stack is a half cylinder of solid plate. The long streamlined surfaces in front of the center line of the stack and nozzle are closed with perforated plate. There are no other obstructions to the flow of gases from the tube sheet.

When the locomotive is in operation the gases and cinders from the tubes flow forward around the solid cylindrical back plate of the separator, the gases then being drawn through the oblique walls of perforated

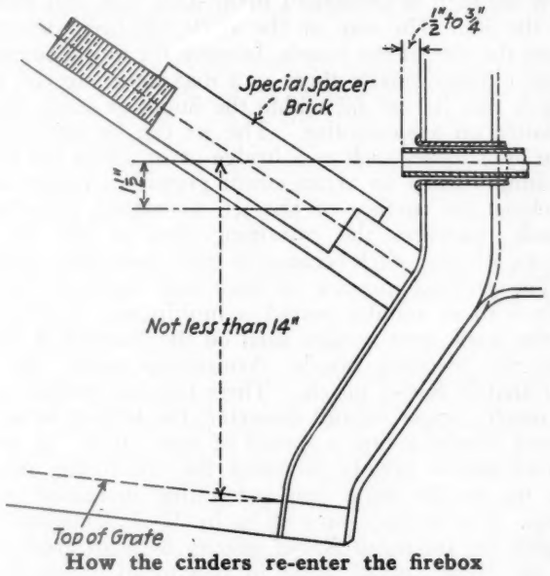


Dimensions of Separator

Line	A	B	C	E	F	Line	A	B	C	E	F
						4	80"-95"	36"	18⅛"	47⅝"	30"
1	50"-65"	24"	12⅝"	32⅝"	18"	5	90"-100"	40"	20⅝"	52⅝"	34"
2	60"-75"	28"	14⅝"	37½"	22"	6	95"-105"	44"	22⅝"	58"	38"
3	70"-85"	32"	16⅝"	42⅝"	26"						

Arrangement and functioning of the locomotive superdraft

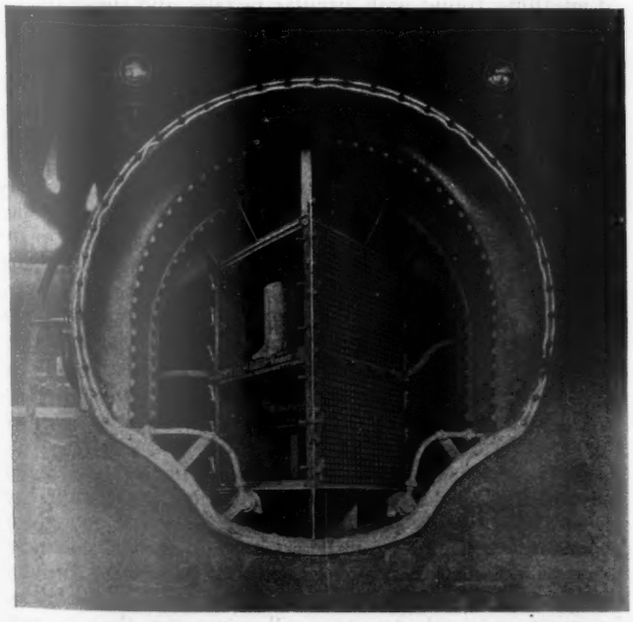
plate, while the cinders continue toward the front end of the smokebox in a direction approximately parallel to the surfaces of the netting, to fall at the bottom of the smokebox. Here they are picked up by steam-operated ejectors, which blow them back through 2½-in. return pipes to the firebox. The return pipes pass through 3½-in. boiler flues and terminate from ½ in.



How the cinders re-enter the firebox

to ¾ in. inside the rear tube sheet. A special spacer brick is provided in the arch just back of each tube to permit the cinders to fall through to the fire.

In the performance of its primary functions of preventing the discharge of cinders from the stack and reclaiming the heating value of cinders which pass into



Location of the separator and ejectors in the front end

the front end, the Superdraft equipment possesses a number of other advantages. Since the clearing of the front end is no longer a function of the drafting equipment, high gas velocities are unnecessary and the separator itself offers very little resistance to the flow of gases to the stack. The relation of the cinder flow to the separator is such that only a small portion of the cinders come in contact with the screen or perforated plate, and then parallel to the surface rather than against it, which materially reduces the netting wear. This also reduces the tendency of the netting to plug. As a further precaution in this respect and also to prevent any water dripping from the stack getting into the front end, a water-tight rim is placed about the edge of the bottom plate of the separator, and any water which drips onto the plate drains into a water-tight well inside the sleeve support which surrounds the exhaust pipe. Such water as accumulates here is evaporated when the smokebox again becomes hot.

The high draft efficiency and elimination of cinder losses are said to result in a substantial increase in locomotive efficiency. Other advantages are the elimination of fire losses to railway and other adjoining property, reduction in the cost of cleaning ballast, and greater comfort and cleanliness both for passengers and employees.

Controlling the Cost of Locomotive Maintenance

(*Continued from page 286*)

lowering of steam pressure—cold air through the flues as we had when locomotives were changed at every division point of a hundred miles or so; in fact, we found no more work reported on a certain engine whose run was extended from 400 miles to 650 miles. This is one question on which the operating department can be of material help, and we find them very willing to go along with us on any change they can make to help us extend locomotive mileage. This applies in particular to making their switch-engine assignment so that power can be doubled over and get two or three shifts a day out of it.

When the expected months of service drops to three on any locomotive, a work report for the shop is made up. This report shows the attention the engine will need. It also shows the thickness of driving tires, diameters of all driving journals and of all side-rod and main-rod pins. This information, together with a list of needed material that is furnished by the master mechanic, is sent to the shop superintendent who is then in a position to prepare intelligently for the repairs to the locomotive. A copy of this material list is also sent to the stores department, who begin to assemble the material, and who are usually able to deliver it all to the engine as soon as it is in the shop.

We have found it very beneficial when new power is under consideration to call the men who are going to maintain it into conference with the people who are designing it. Many changes have been made as a result of these meetings, which tend to reduce maintenance cost after the locomotive went into service; for instance, in paneling of jacket in the vicinity of the flexible staybolt caps. A slight change in the engine truck to facilitate the removal of cellars and wheels, lengthening of the piston rod a little so that the cylinder packing can be removed without extracting the rod from the crosshead—all of these things help to reduce maintenance costs. In considering new locomotives, too much emphasis cannot be placed on giving the mechanical engineer ample time to work out a well-designed machine. Many mechanical organizations who apparently have a high locomotive maintenance cost, are really doing an efficient job of maintaining a poorly-designed engine and there are other organizations that are doing a poor job of maintaining a well-designed one.

Each month all of the master mechanics, assistant master mechanics and other special men are called together, at which time each engine or passenger motor-car failure is fully analyzed and responsibility fixed, and, if possible, a recommendation is made to prevent a recurrence. A complete report is made of the findings and recommendations, and a copy sent to each supervisor on the railroad, who has anything to do with maintenance of power.

In conclusion, low locomotive costs are attained only by continued effort on the part of the mechanical organization, with the co-operation and help of the operating and stores departments. Good tools and facilities have an important bearing on this question, but, without the close checking and supervising that has been mentioned, tools and equipment, alone, will not keep the maintenance cost at a minimum.

Grate Design and Smoke Prevention*

By J. W. Hulson

IN view of the close relation between fuel economy and smoke prevention, I shall endeavor to point out advantages and improved performances resulting from correlating grate design with front-end design.

A decided improvement in grates in the past few years has come as a result of consistent study along the lines of fuel conservation and the necessity of reducing the cost of locomotive repairs. Larger grate areas, lower combustion rates, improved stoker distribution and the use of smaller coal have affected firing conditions. An improvement in firing conditions has been the purpose of these changes, but another element has had to be worked out—the question of total air inlets through the grates.

Smoke from any coal-burning furnace is evidence of incomplete combustion, and indicates that one or more of the four elements—time, temperature, air and mixture—are either lacking or out of balance.

The combustion rate is dependent upon air flow, or the volume of air that can be supplied in a given length of time.

Stack size, nozzle design and the proper alinement and adjustment of both, plus the restrictions to gas flow, determine the capacity of the front end for any given back pressure.

The restrictions to gas flow consist of deflector and diaphragm in the standard Master Mechanics' front end, superheater dampers where used, the net gas area through the flues, the arch, the fire bed, grates and ash pan.

The old purpose in grate design had the idea of lowering the restriction to air flow by holding the percentage of air opening through the grates as high as possible on the assumption that a greater air flow would result and increase boiler capacity by supporting a higher combustion rate. In some instances this proved true, because ash-pan or grate openings were restricted in relation to front-end capacities, but it did not solve the problem for all conditions. Now we are concerned in adjusting air flow through the grates to the front-end capacity, whatever it may be.

From the grate openings to the top of the stack, the locomotive boiler and front end is a closed vessel, disregarding for the moment air openings around the stoker, door, etc. No more air can get into the firebox than is ejected from the stack. Given a front-end temperature of 500 deg. and air at 60 deg., we can only get one cubic foot of air into the firebox for every two cubic feet out the stack. The volume of gas that can flow through is dependent upon stack size and velocity of the jet. The size of the stack has been dependent upon the size of the nozzle, because for any diameter of plain circular nozzle there is a maximum size of stack which this jet can fill within the limits of stack heights possible on a locomotive. The jet can be increased in size by a baffle, such as a bridge at or above the nozzle opening. Such an arrangement permits a larger stack. Nicking the surface of the jet, as with a Goodfellow nozzle, increases the entraining area of the jet and allows a larger stack because of some spreading effect.

The greatest increase in stack size, however, is possible with an annular ported or multiported nozzle, such as the waffle-iron nozzles used on the Norfolk & Western, the Sweeney nozzle, Armstrong nozzle and the star-shaped Kiesel nozzle. These nozzles produce a jet of much greater overall diameter, the largest being the Kiesel nozzle, giving a spread of over 16 in. A multiported nozzle greatly increases the entraining area of the jet, at the same time permitting increased nozzle areas. For instance, on a 28-in. by 32-in. Mountain-type engine we are using Kiesel nozzles with an area of 52 sq. in., 16-in. spread, equal in area to an 8⅛-in. round nozzle. The stack diameter in this case is 25⅝ in. Another instance is a 31½-in. by 32-in. Consolidation engine with a 45-sq.-in. Armstrong nozzle, 12-in. spread equal to a 7 9/16-in. round nozzle, with a 20-in. diameter stack. The back pressure is, of course, correspondingly reduced, as compared with circular nozzles.

The capacities of these combinations are far in excess of anything found with circular nozzles and small stacks, and the use of them changes and simplifies the problem of grate design and air control. Large increases in combustion rates and, as a result, increased boiler capacity are available, and the problem of air control—to secure the highest combustion efficiency—comes directly to a question of grate design.

How to compute the air inlet involves the restrictions between the stack and grate. Beginning at the nozzle, with a Master Mechanics' front end the deflector plate is the first restriction. Next is the netting; then the flues, the arch opening, the fire bed; and last, the grates. With the Kiesel front end there is no restriction between the nozzle and the front flue sheet. This is also true of the Type-C Cyclone front end. Less restriction increases the flow for any stack and nozzle combination.

The net gas area through the flues is unalterable, and this area practically governs all other areas.

With increased capacity of the front end, with too high ratios used for the total air inlets through the grates, it is readily seen that the air flow for any given front-end draft is dependent on the fire-bed thickness to restrict and control excess air. The air inlets through the grates are reduced to control the fire-bed thickness. In most cases the grates will represent the greatest restriction from the nozzle to the ash pan. This makes it necessary to provide different finger castings, in the case of Hulson grates, for different classes of power, but, due to the low maintenance, this change in so-called standard grates for all classes of power is not a serious handicap. The adjustment of the air inlet through the grates amounts to the same thing as adjusting the air valve in a carburetor. The air inlet is fixed, the draft and coal delivery determining the combustion rate.

* Abstract of a paper presented at the annual meeting of the Smoke Prevention Association held at the Hotel Sherman, Chicago, June 20 to 23, inclusive. The author is secretary-treasurer of Hulson Grate Corporation, Keokuk, Iowa.

Ratios for these various conditions have been developed, based on front-end gas analysis. Firebox temperatures are high, excess air is reduced, and boiler capacity is greatly increased. For example, the indicated horsepower on the Mountain-type engine referred to has been increased from 3,800 hp. with a Master Mechanics' front end to 4,900 hp. at 58 m.p.h. with the Kiesel front end. The tonnage rating on these engines has been increased 30 per cent.

The Tuyere-type grate, with its baffled air admission, plays a very important part in these adjustments because of the very thin fires. With the restriction at the stack relieved, working at long cut-off and slow speed, the firebox drafts run very high—up to 4 and 5 in. of water. The Tuyere-type grate eliminates the tearing action; the velocity of the incoming air is reduced, but not the volume. Stoker distribution is perfect. Once set, the distributor jets are not disturbed for the trip, except for pressure on the manifold to compensate for any change in coal size or moisture.

Leaving the terminal, the fireman is not concerned over a heavy fire, built to reduce the smoke while getting to his train, as it will burn down properly with increased draft. Coming into the terminal with a clean, level fire, and firebox temperatures up, he can get to the roundhouse without uneasiness for smoke.

This increased engine capacity, better fuel performance and perfect fire conditions are the result of studying the gas flow from the grates to the top of the stack for any given set of conditions, and arriving at the right adjustment of areas between these two points. The new designs of front ends with greater capacity make these adjustments possible, with a large reduction in back pressure, and the improvement, smoke conditions included, is the result of more complete and more efficient combustion.

Controlling Maintenance Expenses by Design

(*Continued from page 281*)

any one of these ways can readily be obtained from Fig. 3.

The forces on the frames at the axle centers on the leading side of the locomotive amount to 330,000 lb. for curve "A," 300,000 lb. for curve "B" and 290,000 lb. for curve "C." Assuming 80,000 miles between shopping for the locomotive in all instances, and referring to Fig. 3, it will be observed that the total expenditure for maintenance will be $20,500 for curve "A," $16,500 for curve "B" and $15,500 for curve "C." In the locomotives wherein the booster is used, the maintenance expense will be increased by $400, due to the upkeep of the booster. The total expense involved in maintaining the booster-equipped locomotives will be $16,900 for curve "B" and $15,900 for curve "C." The saving in maintenance for the shopping period as compared to the locomotive without booster shown by curve "A" will be $3,600 for curve "B" and $4,600 for curve "C."

The annual savings resulting from a reduction in the maintenance expense because of the method of obtaining total power will depend entirely on the mileage operated. With an average of 4,000 miles per month, or 48,000 miles annually, it will be observed from Fig. 6 that the gross return on the investment in the booster unit as applied, neglecting any advantage to invested capital because of the possible saving in weight which might accrue, will amount to 31.5 per cent in the event that the locomotive as shown by curve "C" in Fig. 5 is considered. It is further observed from this same chart that the net saving, after taking into consideration the interest, depreciation, tax and insurance charges on the applied booster, but without benefit of any weight reduction which may be made, will amount to 20.5 per cent.

Another instance wherein design may effect economies in maintenance is brought out by the description of an all-service locomotive by W. E. Woodard before the New England Railroad Club. In the design suggested, there was a method proposed whereby it was possible to reduce the cylinder centers by a substantial amount as compared to the usual practice. Obviously, such a change in design should not alter the power of the locomotive to any degree, nor should there be any weakening of the locomotive structure. A change in the cylinder centers of a locomotive will have a decided effect on the forces exerted on the frames at the axle centers. In the particular locomotive described, the reduction in cylinder centers will lower the forces on the frames on the leading side of the locomotive from 245,000 to 238,000 lb. The value of designing the locomotive in this manner can be obtained by reference to Fig. 3, wherein it will be observed that with 90,000 miles for a shopping period, the expenses will be reduced from $13,600 to $12,900, resulting in a saving of $700 in the cost of maintaining the locomotive. The locomotive was designed for all-service work and should normally average approximately 60,000 miles annually. The savings resulting from this deviation from the usual design will be in excess of $500 annually.

There are other features entering into the design of a locomotive which may be analyzed in a similar manner. The important fact is that it is entirely possible to predict accurately from the past performance the possible savings for any alteration in the existing design of the locomotive. This is important, as it gives a definite means of controlling maintenance expense, which starts with the original conception of the locomotive and continues during its entire useful life. A complete conception of the part taken by locomotive design cannot prevail without a thorough understanding of its exact influence on the maintenance expense. By no other method will it be possible ultimately to reach the desired control of maintenance expense and obtain the maximum economic benefits from the use of capital.

* * *

Material for roof work at the Milwaukee (Wis.) shop of the C. M. St. P. & P. is placed on an elevated platform from which it is easily applied to the cars

EDITORIALS

Machine Tool Requirements

The interview on the pressing need of new machine tools in railway shops, which will be found on another page, had just been sent to the print shop when word was received from the Chicago Great Western that several large new machine tools are to be installed in its Oelwein shops. The superintendent motive power whom we interviewed emphasized two prime reasons for the early purchase of new tools. First, there have been marked improvements in such tools, as to efficiency and capacity, in the last few years; second, the centralization of repairs at one or a few points makes it possible to place more of the work on a production basis, thus justifying the use of more highly specialized tools.

President P. H. Joyce, of the Chicago Great Western, in his letter to us, mentioned still another reason, although it may have been the intention of "S.M.P." to include it under his two points, since it is more or less closely related to them. Indeed, it is quite likely that such is the fact, for his road does operate a considerable number of modern locomotives. The Chicago Great Western tools are to be installed "to replace obsolete machinery which is not suitable for work on modern heavy locomotive equipment."

Too much care cannot be exercised in the selection of such tools. It is not a question of buying standard machines, as one buys bolts or nuts or ties, but rather of purchasing the tool best suited for the particular work to be done. Such tools cannot be purchased on a competitive price basis. Their purchase should be predicated on an engineering analysis of the results to be obtained and of the return upon the investment for the particular tool on the classes of work for which it will be used.

Improved Service, Greater Economy

Federal Co-ordinator Eastman in his statement to the regional co-ordinating committees on July 14, made the following pointed and constructive comment upon the elimination of waste and preventable expense:

> **Some have looked upon this search for waste and preventable expense as merely a project for limiting and curtailing service. If I thought of it as that, I would not be for it. More than ever it is important, with the competition by which railroads are now confronted, for them to give not only good but better service. They cannot afford to wean away traffic. That will drain away net earnings quite as effectively as any unnecessary expense. It is my hope that in our search for economies we shall find means of improving service, both freight and passenger, and shaping it to meet present-day conditions.**

Competition has in recent years made heavy inroads into the passenger and freight traffic of the railroads. While some of this was due to unfair handicaps to which the railroads were subjected, progress is steadily being made to correct these evils. A long forward step in this direction may be taken if the competing types of carriers are placed on a more comparable basis with the railroads under the application of the Industrial Recovery Act.

Entirely aside from these handicaps, however, the railroads are in a position to build up their traffic by making improvements in the service, and in this respect the mechanical department can play an important part if it can receive the support of the executives, always assuming, of course, that it is possible to finance the necessary improvements. One need only to mention, for instance, the air conditioning of passenger trains and the many other provisions that can be made to insure more comfortable, easier riding and convenient equipment. Such measures should help materially to win back traffic from the private automobile, and possibly from the airplane, as well.

There are good reasons to believe that the weight of the freight cars can be very greatly reduced and that these cars can be made to ride much more easily, thus reducing the possibilities of damage to the equipment and the lading, and making it possible to ease up on some of the stringent packaging requirements which greatly increase the cost of shipping some types of commodities in railroad freight cars.

Modern locomotives can be operated at greatly reduced costs as compared to the older types of equipment and there seem to be large possibilities for special designs for various types of service.

The necessity for speeding up the repair and maintenance programs has caused many railways to reopen their shops; those which have been in operation during the depression are working longer hours with larger forces. The trend toward improved locomotive utilization in recent years, with the steps that have been taken to keep the locomotives in prime condition at all times, and the fact that there has been a strong tendency to consolidate locomotive and car repairs at a few points, will tend to produce lower unit costs for repairs and maintenance. Improved machine tools and shop equipment are available, the use of which will increase the efficiency of shop operations.

These are only typical of the changes and improvements which the mechanical department can make and which will place the railroads in a better position to build up their traffic, both freight and passenger.

Steam Locomotive Evolution

The interesting exhibition of the most powerful modern locomotives, as well as working models of some of the earliest designs, at A Century of Progress Exposition in Chicago this year leads to a natural inquiry as to what real improvements aside from increased size and power have been effected. For purposes of comparison, reference may be had to the typical 4-6-0 passenger locomotive or 2-8-0 freight locomotive of 40 years ago. With 19-inch cylinders, 165- to 180-lb. boiler pressure, and using saturated steam, these locomotives of 40 years ago developed less than 350 hp. per driving axle. This power output per driving axle was increased to 475 hp. in 1913; to 575 hp. in 1923; and to over 1,100 hp. in 1933. Similarly, the unit fuel consumption, expressed in pounds of coal per drawbar horsepower-hour, was reduced to 6½ lb. in 1913; to 5 lb. in 1923;

and to less than 3 lb. in 1933. This notably improved performance, especially in recent years, must be credited to locomotive designers in both the railroad and the equipment supply fields. Without the effective co-operation of the locomotive builders, as well as manufacturers of capacity- and economy-increasing devices and accessories, the steam locomotive could never have been developed to meet the demands now made upon it.

The important part which research and development by the manufacturers have played in the improvement of steam locomotives is amply demonstrated by the results accomplished. Again comparing the locomotive of 40 years ago with that of today, we find not only steam pressures increased 60 per cent or more, but steam temperatures raised from 390 to about 650 deg. F.; hourly combustion rates decreased from 200 to 100 lb. of coal per sq. ft. of grate area with attendant economy, and steam per indicated horsepower-hour reduced from 28 to about 18½ lb. The earlier freight locomotives had 57-inch driving wheels and axle loads of 40,000 lb., which may be compared with the 69-in. to 72-in. wheels and axle loads seldom less than 60,000 to 65,000 lb. and sometimes over 70,000 lb. of the modern locomotive. Tender capacity has been increased from a maximum of about 8,000 gal. of water and six tons of coal to 22,000 gal. of water and 30 tons of coal. Within the same period average tractive force has increased from 35,000 to 70,000 lb. Substantial as these performances are, they fail to give an adequate picture of the real performance of modern locomotives as compared with those of early design, owing to the great increase in steam-generating capacity and overall efficiency which permit hauling more than twice as heavy train loads when the speeds reach 30 to 45 m. p. h. or more.

A New Problem Looms Up

In 1912 the Class I railroads spent a little more than half a billion dollars for equipment maintenance and fuel. At that time fuel constituted the largest of the operating expenditures—224 million dollars—while locomotive and freight-car repairs accounted for 158 and 140 million dollars, respectively. By 1929 locomotive repairs stood out as the largest single item of operating expense—409 million dollars—followed in order by freight-car repairs and fuel, with 338 and 336 million dollars, respectively. It is significant that fuel, once representing the largest of the three major expenditures, has now become the least of the three.

It is conceivable that, back around 1912, a group of railroad officers might have got together and in searching for opportunities for economies logically selected the item of greatest expense and decided that "Something has got to be done about this." History records the fact that along about that time the International Railway Fuel Association began to be an important factor in mechanical—and transportation—department activities. The work of the association and its accomplishments are too well known to need recounting, but it is worth while to note that, over the intervening years, by concentration on fuel selection and distribution, improved firing practices, the utilization of improved locomotive designs and the development of higher standards of maintenance, the association, led by able men, has been influential in saving the railroads millions of dollars by cutting the fuel bill so that it is no longer the largest item of expense.

The work of the Fuel Association serves as an outstanding example of the value of and the results accomplished by an organized, systematic effort concentrated on a single problem over a period of years. What has been done in cutting fuel costs on American railroads has been accomplished because the original tremendous expense for fuel demanded action, and by devoting specific effort to it a real contribution has been made to operating economies.

Within the 17 years between 1912 and 1929 the railroads of this country made great strides in improving train operation. Traffic increased tremendously along with the industrial development of the country. In 1912 total net ton miles amounted to 264 billion; in 1929, to 489 billion, an increase of 85 per cent but the capacity of steam locomotives and their utilization also increased greatly during this period so that locomotive miles from 1912 to 1929, increased less than 2 per cent. The expenditure for fuel increased about 50 per cent. During the same period expenditures for freight-car repairs increased about 140 per cent and expenditures for locomotive repairs increased about 160 per cent. In view of the attitude of many railroad executives toward expenditures for equipment maintenance, which have been looked upon as a necessary evil of furnishing transportation, it is not surprising that these expenses have increased as they have. The important point is, what are we going to do about it?

For several months attention has been called in these columns to the fact that as traffic increased the problems of supplying adequate motive power for greater traffic movements would gradually become more acute and that unless an intelligent motive-power policy was developed by American railroads their expenditures for locomotive operation might increase out of all proportion by a return to service of obsolete power with attendent increases in expenditure due both to the necessity of rehabilitating this obsolete power, as well as the operating losses in service.

Sufficient study has been made of the motive-power situation in this country to serve as a basis for determining an intelligent policy, and it is evident that there are several factors, each important in themselves that must be co-ordinated in any such policy in order to assure its success. Any substantial and real economies in maintenance must embrace proper design in the first place—design with a view to less expensive maintenance; a thorough study of repair-shop facilities and methods and finally the question of management. As one student of maintenance costs points out in an article entitled "Controlling Maintenance Expense by Locomotive Design," which appears in this issue, the control of such expense starts with the design of the locomotive and an accurate knowledge of this expense offers the best solution to controlled maintenance. The writer goes so far as to say that "By no other method can accurate control ever be obtained."

Developments in locomotive design prior to 1930 and developments which have been going on since that time offer tangible proof that the costs both of locomotive operation and maintenance may be materially reduced by replacing a considerable part of the more than 80 per cent of the motive power in this country that is now over 10 years old.

Unfortunately the problem of locomotive repair facilities in relation to maintenance costs has not been given the attention it deserves. In spite of the fact that many shops and engine terminals have been abandoned and consolidated with other facilities, we still have in service repair facilities that are, in proportion, just as obsolete as the locomotives they are intended to maintain. What is needed is a study made in some manner that will assure the formulation of intelligent maintenance policies—

in relation to economical locomotive operation—and the utilization of the best methods so far developed for the industry as a whole. The difficulty in attempting to suggest improvements in repair work arises out of the fact that so little real information has so far been collected. The study must first be made and in the case of those roads that have made progress in this respect the need for modern facilities is evident. This is strikingly borne out in an interview which appears on page 287 in this issue.

Last, and very important in the solution of this problem, comes the question of proper management. No railroad officer can now ignore the maintenance-of-equipment problem. Railroads are no longer made up of individual departments, each working to their own ends. Following such a policy means that while expense in one direction is being satisfactorily controlled costs in another direction mount steadily higher. The history of the relation of fuel and repair costs over the years previously mentioned are proof of this point. Accurate cost control, properly co-ordinated in relation to all operations is the only way in which weaknesses in individual departments or operations can be shown up. An article by O. E. Ward, superintendent of motive power of the Burlington entitled "Controlling the Cost of Locomotive Maintenance" appearing on page 285 in this issue tells how one road has successfully co-ordinated accurate cost control.

If a fuel bill of 224 million dollars in 1912 was a sufficient incentive to initiate a concentrated effort which has produced real results, a maintenance bill in 1929 of 409 million dollars certainly ought to be worth serious thought.

The Machine Gathers Speed

After a long and gruelling period of inaction during which men have been idle or employed on extremely curtailed schedules, and in which the efforts of those still engaged in the task of keeping the railways supplied with sufficient serviceable motive power and rolling stock to handle what business still remained have been handicapped by insufficient supplies, railway traffic has now reached a volume and continues to increase at a rate which holds forth the promise of a full resumption of equipment-maintenance operations at no distant date. For the first time since the end of 1931, car loadings passed the 600,000 mark for the week ending June 24 and reached over 648,000 for the week ending July 15. There has also been a marked increase in railway travel since the opening of the Century of Progress Exposition at Chicago at the end of May.

The effect of this increase in freight traffic, which has been rapid since early in June, has been noteworthy in two respects. Net railway operating income is rapidly approaching a level where the future solvency of the railroads as a whole will be assured, and equipment surpluses are rapidly melting under the benign rays of renewed business activity. For the month of February net railway operating income for the Class I railways was less than $9,900,000 and in March $10,500,000. For the month of April, in which weekly car loadings passed the half million mark, net railway operating income had increased to $19,000,000, and for May it again increased to $40,700,000. Based on the reports for June of twenty railroads, whose reports for that month are now available and which show an increase over May of 55 per cent, a net railway operating income for all Class I railroads of well over $60,000,000 is indicated for June.

During the first half of March, when weekly car loadings were at their lowest, the average freight-car surplus was slightly more than 691,000. For the second half of March this was reduced by about 9,900 and steadily declined for each succeeding half-month period by from 29,000 to 37,000, until the middle of June, when the surplus stood at 522,785. During the second half of June this was reduced by over 69,000 to 453,541, a total decline in three and one-half months of 34.4 per cent.

The rapid growth of traffic and earnings has already had a widespread effect on car and locomotive maintenance programs, some indication of which is contained in an article in the News department of this issue in which the reopening of closed shops and the extension of working time and the increase in the number of employees in others are reported for 27 railroads. With a continuance of the increase in traffic, or even with its maintenance at existing levels, these programs will continue to be expanded as the railroads face the necessity not only of restoring current wear and tear, but of catching up on a tremendous accumulation of deferred maintenance. One railroad has already reported a sizable order for machine tools which are necessary for the effective handling of the maintenance on its heavy modern motive power. Many others face the need for similar action in order that the enlarged programs at central repair points made necessary by the abandonment of many smaller shops may be handled efficiently. Some roads are finding it necessary to restore their supply of small and portable tools which have run down as the result of the necessity for extreme curtailment of purchases during the past two years.

The machine has again been started and is rapidly being brought up to speed.

NEW BOOKS

HANDBOOK OF BUTANE-PROPANE GASES. *Published by Western Gas, 810 South Spring street, Los Angeles, Cal. 280 pages, 8½ in. by 12 in., illustrated. Price, $5.*

Both the general and technical phases of the liquefied petroleum gas industry in its several branches are dealt with in this first edition of the Handbook which represents the joint effort of a score or more individuals directly associated with butane-propane enterprises. The book opens with an historical chapter taking the industry through its early and transitional stages into the time of current expansion. The contents of the other chapters are planned to cover each branch of liquefied petroleum gas service, in so far as possible, as a unit—properties of the gases, their manufacture, transportation, utilization and distribution. The book also contains a Catalog Section, a Buyers' Guide, a Directory of Central Plants, and miscellaneous data.

THE TECHNICAL MAN SELLS HIS SERVICES. *By Edward Hurst, S.B. Published by the McGraw-Hill Book Company, New York. 239 pages, 5½ in. by 8 in. Bound in cloth. Price, $2.*

This book is designed to help a small section of the unemployed—college graduates, especially the technically trained. The author has scrutinized the reasons for failure or success of graduates whom he has helped and endeavors to show the reader how, by selling his services instead of asking for a job, to convert the employer's "no" into a "yes." A series of cases covering the broadest interpretation of technical training illustrate the application of scientific methods to job getting. The characters in the book are a hypothetical employer, Mr. Jones, and a camouflaged teacher, Professor X.

With the Car Foremen and Inspectors

Conditioning The Empire Builder*

KEEPING passenger cars in good running order, as well as cleaned, iced, watered, etc., is very important, especially now that the private automobile, the highway bus, as well as the air service, make it necessary that the traveling public be transported as comfortably, safely and speedily as possible to meet this competition.

The Great Northern has a through train known as the Empire Builder running between Chicago and the Pacific coast, being handled over the Burlington line between Chicago and St. Paul, Minn. As the train schedule provides for only about 20 min. at St. Paul, it is essential that we have enough men, consisting of car men, inspectors, cleaners (inside and outside), ice men, electricians, etc., on hand at the depot to get the train fully inspected and supplied for its long trip to the West coast. These men are brought to the depot from the Mississippi Street coach yard in a bus used for this purpose to save time, and, as soon as the train arrives, they go about their various duties as quickly as possible so as not to delay the train in any way. In case any cars are discovered with defects which cannot be repaired at the depot, the coach yard is notified and a switcher moves any type of car needed to the depot to replace the defective car.

All of the various classes of Empire Builder cars are spotted first out at the coach yard and properly turned so they can be handled without delay when called for. Of course, the cars in this train cannot be washed on the outside, except the windows, nor can they be cleaned on the inside other than swept out and dusted, in the short period the train is in; but all of the wheels, trucks, etc., are gone over carefully by the inspectors. Steam connections are cut and coupled up by steam men when necessary and any leaks remedied with new gaskets or diaphragms. In cold weather the steam has to be watched carefully to see that no valves or connections are frozen and that all steam traps are functioning properly so that the entire train is heating. All air brakes and triple valves must be watched and the air tested so as to make sure that the valves are in proper working order. Triple valves are changed if found to be sticking or inoperative. All electrical equipment, such as axle generators, pulleys, belts and connectors, must be inspected to see that they are in good condition and, if necessary, ice and snow removed from the machines to keep the belts from slipping, which decreases the efficiency of the lighting systems. After these matters have all been taken care of the train is ready to leave, and it is very important that this train be in first-class condition when leaving the terminal.

Handling Other Passenger Train Cars

Passenger cars which operate regularly in and out of the terminal are given a thorough inspection both inside and outside on arrival at the coach yard and all necessary repairs made during the layover period, if possible. In case of any defects that cannot be repaired during this time, the car is set out for one or two trips until the necessary repairs can be made, substituting one of the extra cars which is on hand in the coach yard. As soon as these trains are brought to the coach yard from the depot, the car-men inspectors go over the trucks, wheels, etc., and mark whatever defects they find. If there are defective wheels, or any other defects that cannot be repaired on the track, the yardmaster is notified and the car is moved to the repair-track pit, where the pit crew do the work. During this same inspection period the car washers wash the outsides of the cars, usually with clear water, but every few days when the cars become dull they are scrubbed with an oxalic acid solution. Other men wash and wipe the windows, and on cars that have brass, such as on observation platforms, the brass is polished with metal polish. The roofs are carefully looked over for possible leaks or bare spots, which are painted or repaired, as may be required. After the worn brake shoes are replaced, air brakes tested and old-date triple valves changed, if any, the cars are ready for service, so far as the outside is concerned.

Empire Builder at the Union Station, St. Paul, Minn.

During this same time the inside cleaners, moppers, dusters, etc., are busy with their respective duties. The various men are assigned to certain trains for each day so there is no time lost, but they can all go to work immediately after the train arrives in the yard. In the baggage cars, the floors are scrubbed and thoroughly flushed with a water hose. Often it is necessary to scrape the floors in order to get the dry cream and other matter spilled during the trip. The various racks, desks, etc., are dusted and wiped and head lining washed at various intervals. All lamps are refilled with oil and chimneys replaced, if broken, and, if the car is electric lighted, all burned-out bulbs are replaced. Doors are kept tight with weatherstripping to keep the cold as well as the rain out. This is very important to prevent claims in case the car may be loaded with silk or other

* Abstract of a paper presented by V. A. Tetu, superintendent car shops, Great Northern, St. Paul, Minn., before the May 1 meeting of the Northwest Car Men's Association.

delicate material. The floors are painted often as they get considerable hard wear.

In the mail cars, the same conditions prevail with the exception that there are more racks, partitions, stanchions, etc., to keep tight as they rattle and become loose and the U. S. Postal rules are very specific in the matter of keeping the insides of these cars in first-class shape. Smokers and coaches are much the same as to their cleaning, but the dining cars, parlor cars, observation cars, etc., require special attention and require a great deal of dusting, washing, polishing, etc., to keep them neat and clean in appearance so as to appeal to the comfort of the passengers.

Severe Weather Conditions Introduce Difficulties

The very severe weather conditions that prevail during the winter season in these northwest states often cause difficult conditions to develop in maintaining passenger equipment. When trains pass through territories where the temperature drops down to from zero to 50 deg. below, many things can happen which will cause not only delays to the trains but serious and costly damage to the cars due to freeze-ups. The Great Northern has in use three different methods of heating the cars. The Baker heater, the straight steam heat and the new, improved Vapor system. This latter system is a big improvement over the former types and much easier to regulate, keeping the cars at a more even temperature. Moreover, they are not as likely to freeze up with ordinary care. If any of these systems are allowed to freeze up, the damage often amounts to from $300 to $500. In the case of a diner or a sleeper of steel construction, the contraction of the metal sometimes causes the paint to peel off, which makes another item of expense to replace.

The winter season also has a tendency to develop defective wheels and a great many more wheels are changed during this time than at any other time of the year. Shelled-out wheels are the more prevalent and this is ordinarily caused by the wheels getting heated by the heavy braking and then too quickly cooled by the snow, ice and cold which cause the metal to crystallize and subsequently shell out. We also run into flat-wheel epidemics during the winter and often find as many as 20 to 25 pair on one train. We have, however, a peculiar condition in Northern Minnesota and Canada which gives a great deal of trouble with flat wheels. There is a certain kind of clay soil, or gumbo, in this district which blows on the rails and causes a very slippery condition and, when the slightest application of the air is applied, the wheels slide as if greased and, on several occasions, almost the entire train developed slid-flat wheels. I might mention that during the season 1925-1926, this rail condition was exceptionally bad and caused over 800 pair of flat wheels, all of which were changed within approximately three months.

We have ample facilities at the coach yard for taking care of all light running repairs and are doing considerable heavy work during periods when car shops are shut down. We have two wheel pits, a complete carpenter shop, paint shop, air-brake room, blacksmith shop, tin shop, etc., and these buildings contain sanitary toilets and clothes lockers for the employees. In addition to this, we have an electric shop completely equipped for repairing and maintaining all electrical equipment, overhauling generators, etc., and we recently installed a charging and repair plant for batteries and will now handle all batteries for the eastern district of the system as well as all batteries sent in for general repairs. We have an ice house with a capacity of over 4,000 tons which takes care of all our needs as well as the commissary and dining-car department. We have 12 tracks for each coach-yard use and facilities for handling up to 4,000 cars per month.

Reconditioning Babbitted Bearings on the Shaper

BABBITTED bearings become worn out of shape while there is still plenty of babbitt. In this case to avoid the longer and expensive method of rebabbitting the bearing, it may be placed in a shaper and trued up

Scraping a journal brass with a special shaper tool

by shaving the babbitt with a square edged disk tool of the same size as the shaft or journal on which the bearing is to be used again. The tool is bolted to a square shank which fits into the tool post. The illustration shows a bearing partly scraped.

Gaging Triple-Valve Parts

ADDITIONAL instructions regarding the use of gages for checking triple-valve parts, as specified in Circular D.V.-800 of the American Railway Association, Mechanical Division, have been issued as of June 1, 1933, by Secretary V. R. Hawthorne. Attention is directed to the practice of some triple-valve repairmen of filing triple-valve piston stems to provide clearance for the slide-valve spring, enlarging the slide-valve exhaust cavity to offset improper matching of feed groove and exhaust ports and shortening graduating stems to curtail quick service activity of the triple valve. These changes were made, presumably, because triple valves fail to pass certain tests upon the A. R. A. test rack. Such changes prevent the triple valve from passing the complete code of tests prescribed for freight triple valves and result in improper performance in service.

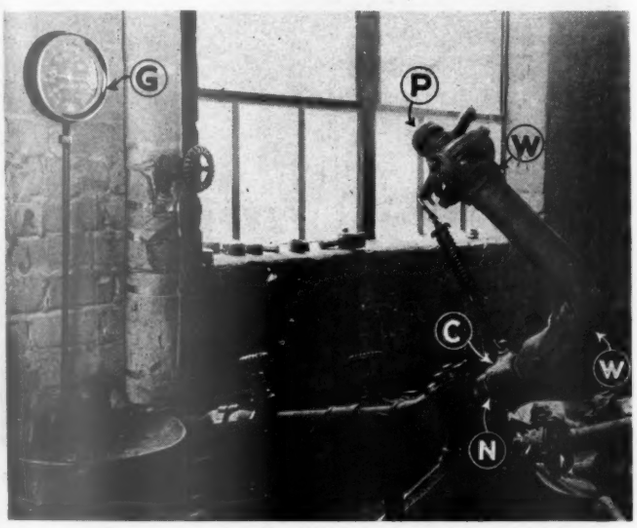
It is important that such practices as above described be discontinued.

Testing Flexible Metallic Connectors

By A. Skinner

IN an article on page 219 of the June *Railway Mechanical Engineer* pertaining to the testing of flexible metallic steam-heat connectors, the test is apparently not entirely adequate since the joints which provide the flexibility peculiar to this type of connector are not tested in the position they ordinarily assume during regular service operation. By laying the connector flat on a test table, as illustrated in the article, there is little if any strain on the gaskets, and joints which are tight in this position possibly may leak when applied to the car in the normal operating position.

A method of testing flexible metallic steam-heat connectors which avoids this difficulty is shown in one of



Effective method of testing flexible metallic steam connectors

the accompanying illustrations. The connector is assembled and threaded into the steam supply pipe with the parts in the same relative positions they will assume during regular service operation. Pipe cap *P* is applied to the outer end of the connector. Steam flow is controlled by globe valves, which answer the purpose and are cheaper than the No. 1106 end valve. Gage *G* is used to show the steam pressure exerted on the connector during the test, this pressure being maintained at about 110 lb. so as to make the test a rigid one and assure that the connector will stand up under greater pressure than occurs in actual service. While the steam pressure is applied, the man doing the test work moves the upper part of the connector both to the right and the left an amount slightly in excess of the movement encountered in ordinary service, and if leakage does not develop at either of the joints or at the gaskets it is safe to assume that the connector can be applied to a car and will not develop leaks in service.

The metallic steam-heat connector shown on the test rack in the illustration is a No. 1136 connector which has been converted, using certain parts of the No. 270 design formerly used. Besides the reclaimed parts, the only additional material used in a 2-in. by 3-in. extra-heavy pipe coupling *C*, a 2-in. by 3-in. extra-heavy pipe nipple *N*, and two soft-steel washers at *WW* of 3½-in. outside diameter, 2½-in. inside diameter and ⅛-in. thickness. These parts are shown in detail in the second illustration, from which it will be observed that the pipe coupling has a steel lug brazed to it at one end and drilled for attachment to the spring support.

It is possible for one man to reclaim or convert six connectors a day, including testing, and if the parts being reclaimed do not need much repair work on them, this production can be increased. Every part should be closely inspected as to its fitness for further service. For example, in connection with the lower joint ring it may be necessary to re-tap the parts where the bearing pin fits, as this is a special thread and the pin, at one time or another, may have been cross-threaded. If, after being re-tapped, the threads show that they are badly worn, the ring should be scrapped. Other parts are closely inspected and re-used only when in condition to warrant further service.

Rack for Fabricating Hopper-Car Sides

IN steel-car repair shops, where hopper cars require the renewal of both sides it has been found advantageous to fabricate the sides on a bench or rack and to hang them on the car in one operation. Many types of tables and jigs are employed for this purpose. The use of tables requires the workman to work in a cramped position under the sides while the rack type permits all workmen to perform their duties while either sitting on a scaffold or while standing in an upright position.

The accompanying illustration shows a side rack of a type used by several railroad steel car shops. While one rack can be used advantageously, it is necessary to remove the completed side before setting side sheets and stakes in place for the other side. Therefore it is recommended that two racks be employed so that both sides can be completed and hung on the car at the same time.

The rack is built from 3½-in., by 3½-in., angles

Additional parts used in converting No. 270 to No. 1136 flexible metallic steam-heat connectors

spaced 5 ft. apart at the base and about eight inches at the top. A 5½-in. angle or flanged steel plate is riveted to the bottom to form a rest for the side sheets and stakes. It is essential that this angle have sufficient rigidity to prevent a sag in the center as this would permit the sides to be driven up out of square. A 3-in. angle is applied to each side of the rack about four feet

Complete car sides may be fabricated on this type of rack

from the base and is permitted to extend outward over the ends about 15 in. to form a support for scaffolding. This scaffold is used while reaming out the holes through the side sheets and side stakes and by the riveter, after all rivets below his shoulders are driven up.

The material can be placed in the rack either by overhead cranes or by portable tractor cranes. After the completed sides are ready to be raised from the rack and placed on the hopper car an overhead jib crane or a traveling crane can be used.

Repairing Metallic Steam-Hose Clamps

THE clamps which hold together the swivel joints of the metallic steam hose often become bent in service but can be straightened by the use of the jig shown in the illustration. By heating the clamp to a dull-red heat and placing it on the jig, a few taps of the hammer brings it back to its original dimensions.

The jig and the two clamps are shown separately at the left in the illustration. At the center and right they are shown in position on the jig after having been straightened.

Repairing Hopper-Car Doors

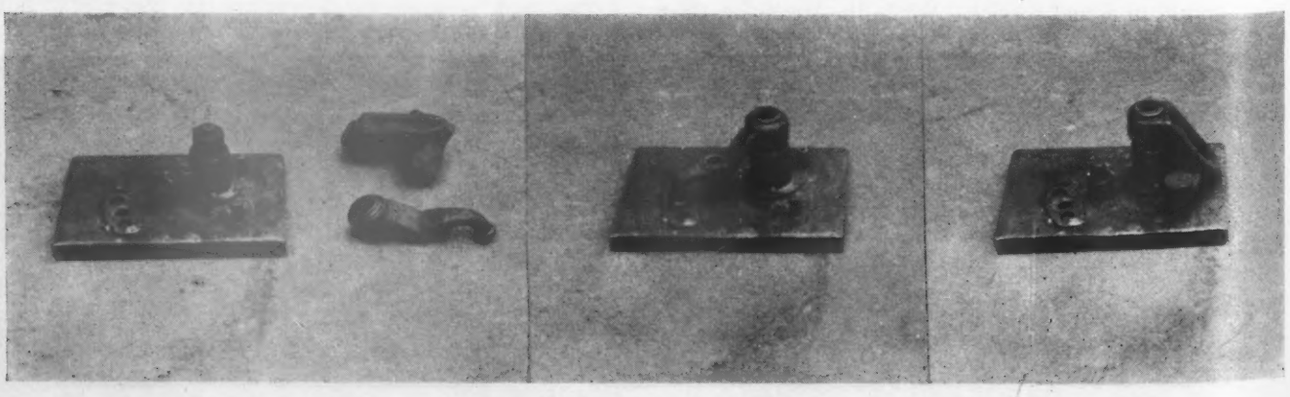
DOORS from steel hopper cars should be removed from each car that is placed in the car shop for general repairs. The doors should be carefully checked to ascertain if they are distorted around the hinge straps or door latches due to heavy deposits of ore, sand or other commodities having been dropped into the cars by clam shell buckets. Where repairs are found necessary the doors should be taken to a location where a bench is provided either to make the necessary adjustments or to tear down and re-fabricate each door. Doors cannot be efficiently repaired at the car for the reason that numerous small templates would be required to check each of the various dimensions.

A permanently located table or one of a portable type as shown in the illustration should be provided and sta-

A portable door rack simplifies the door repair problem

tioned as near as possible to the point where the doors are to be reapplied. The table shown is correctly designed to enable hinge straps for various classes of doors to be attached, with fitting-up bolts, to the template. Then, when the door sheets are placed on the table the holes in the hinge straps and the door sheets can be reamed out and riveted. The bottom door angles and latch assembly can be applied and the doors completely fabricated. There should be no adjustments necessary when they are finally hung on the hoppers.

The door table is constructed from ½-in. by 2-in. strap iron with a 3½-in., by 3½-in., bottom angle to support the door sheets and a 6-in. steel template attached to the top, to accommodate the various types of hinge straps that are to be used.

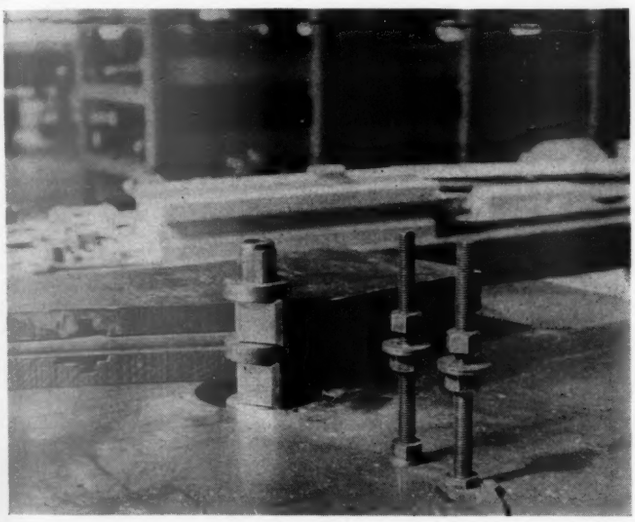


Views illustrating special jig as developed and used for reclaiming bent metallic steam-hose clamps

A Short Cut For the Shaper

THE time required for shaping flat work, such as members for car-door steps, may be cut in half by using two sets of knives on the shaper head spaced by three steel collars, grooved to take the edges of the knives. The knives must match and be balanced so that they tighten perfectly between the collars.

The pattern for the work is made from lumber the thickness of the middle collar, against which it rests.



The use of two sets of knives on the shaper makes it possible to finish two pieces at one time

It is equipped with small spikes which prevent slipping when the pattern is placed between two boards to be shaped. If there are bolts to be bored, the spikes are so placed as to mark the centers of these holes, thus effecting an additional saving in time. The two pieces are then shaped at once, turning over or changing ends as required by the grain of the wood.

Decisions of Arbitration Cases

(The Arbitration Committee of the A. R. A. Mechanical Division is called upon to render decisions on a large number of questions and controversies which are submitted from time to time. As these matters are of interest not only to railroad officers but also to car inspectors and others, the Railway Mechanical Engineer will print abstracts of decisions as rendered.)

Substituting Different Draft Gear

On November 3, 1931, the Southern made repairs to Atlanta, Birmingham & Coast car No. 58061, at which time one Miner friction draft gear complete was applied in place of a Sessions gear and the Southern failed to apply a defect card to the car in accordance with Rule 87 covering labor only for correcting wrong repairs. On receipt of the billing repair card the A. B. & C. took exceptions to wrong repairs and requested the complete charge, both for labor and material, be cancelled in accordance with the fourth paragraph, Rule 87. It called attention to Arbitration case 1678, which it contended is parallel. The Southern admitted that it did not attach a defect card to the car covering wrong repairs at the time the car was repaired and immediately issued counterbilling authority covering labor only which, it contended, is correct, as the repairs in question are sanctioned by a note on friction draft gears in connection with Rule 101 and by the first paragraph of Rule 88, both of which provide for a defect card to be issued for labor only. It cited the last sentence of the fourth paragraph of Rule 87 which specifies that such cancellation in cases subject to Rule 88 applies to labor only.

In a decision rendered November 4, 1932, the Arbitration Committee sustained the contention of the Southern.—*Case No. 1715, Atlanta, Birmingham & Coast vs. Southern.*

Car Owner Responsible for Damage Due to Defect

Nashville, Chattanooga & St. Louis car 70011, a 100,000-lb. capacity flat car built in September, 1913, was damaged on the St. Louis-Southwestern April 8, 1932, and material for repairs to the A end of the car was ordered from the owner April 15, 1932, the handling line being responsible for the repairs. Subsequently the car was reported for disposition under Rule 120 and additional material ordered from the owner for additional repairs to the B end of the car, with the explanation for cause of damage being given that a failure of the center sill back of the body bolster occurred, permitting the car to drop down to a point where a side sill on one side was resting on the rail when the train stopped. No wheels were derailed under the car, nor were there any indications of the car dragging on the rail prior to the time that it stopped. The repairs to the car were authorized with the understanding that responsibility would be determined later. Subsequent examination of the car by the St. L.-S. W. showed that the top cover plate of the center sill had corroded to a point where it was at no point over $\frac{1}{16}$ in. thick above point of failure. The cover plate was covered by decking, and the condition of it could not be determined from ordinary inspection. The center-sill vertical plates were also cracked through the rivet holes where they were secured to the body bolster flange, these cracks being covered up by the flange of the body bolster. There was no rough handling involved in the failure of this car, and no other cars in the train were derailed or damaged, as the damage occurred while running along at a speed of about 30 m.p.h. When the center sills failed, the train-line was broken and the brakes on the train were set, causing it to come to a stop. The N., C. & St. L. contended that the damage to the car came within the scope of paragraph (a), Rule 32, which makes the handling line responsible for all damage due to either or both ends of a car dropping down on the rails or the ground. The St. L.-S. W. contended that the responsibility for the cost of repairs to this car rested with the car owner, the case being similar to Arbitration Case No. 1677, with the exception that in the case mentioned the center of the car was riding on the rails, while in this case only the diagonal brace touched the rails and this could not be construed as the body of the car dropping on the rail as mentioned in Rule 32.

In a decision rendered by the Arbitration Committee on November 4, 1932, it was held that the car was not subjected to unfair usage under the intent of Rule 32 and that the car owner is responsible for the repairs.—*Case No. 1716, St. Louis-Southwestern vs. Nashville, Chattanooga & St. Louis.*

In the Back Shop and Enginehouse

It's a Great Life!

By H. K. Allen

WHEN Joe Cummings, the night foreman, sauntered into the roundhouse at 5 p. m., his customary time, things looked about as bad as usual. Mike O'Connor, the day roundhouse foreman, was literally "reaching for the moon." Machinist Winks had just turned off about 3/32 of an inch too much from the last side-rod bushing that the storekeeper had in stock, and that tied up the 3477. All of the 37 stalls were plugged, a hogger on every pit. Some dead and a few steaming. A side rod off from this one and the tank jacked up on the next one. A front end open here and there and the blowers roaring on a few more. For nine years he had viewed practically this same set-up.

On his way to the office Joe stopped long enough to cast a glance at the call board. The "Steel Special" and the "South Mine Run" were chalked up for two sections, eight extras were lined up for a call before midnight and, to complicate matters more, two Pacifics were ordered for a couple of World's Fair excursions at 11 p. m. Joe reflected that this line-up would draw pretty heavy on the supply of serviceable power around Riverdale for that one night.

Mike O'Connor was already in the office when Joe arrived and was in the act of removing the grease from his hands with a wad of cotton waste preparatory to making his final visit to the washroom. He greeted Joe with the usual grin and the customary "Hello Joe."

"Well, what's the set-up tonight, Mike?" asked Joe as he started to shed his coat and shirt and make ready to climb into his working clothes.

"Swell," replied Mike, "that fat-head Winks just jimmed the last side-rod bushing we had in the storehouse for the 3477. The 3384 and the 2788 are tied up for stoker worms and the two 'Mikes' in 27 and 28 have got to have their flanges trued up. The 3110's on the drop pit with her front and back drivers out and the 2702 and the 3566 need tank wheels."

Joe Cummings was now studying the work reports for the engines in the shop and, while conscious of Mike's proverbial tale of woe, he discovered that there was nothing on the ready track, three 'Mikes' and a Pacific on the inbound inspection pit and nothing available for the "Alley Run" at 6:15. A note from the hostler that the coal tipple was empty and that the spout was torn off the sandhouse also helped to ball things up.

"So long, Joe, leave me a couple of hot ones on the ready track in the morning," were Mike's parting words as he made a hurried exit through the door to catch the 5:20 for home.

For reasons of economy the roundhouse clerk had long since been dispensed with and, in addition to his already numerous duties, it was up to Joe to keep a keen ear trained toward the telephone. A "cow-bell" installed on the wall at the center of the house was connected to the 'phone circuit and its jangle is what sent Joe hurrying back to the office after his first start toward the inbound inspection pit.

The chief despatcher merely wanted to get a line-up of available power and, of course, was not perfectly satisfied when Joe told him he had not made a check of it yet.

Again heading for the inspection pit, Joe tried to visualize an engine for the Alley Run. Fifty minutes to go and only one hope—the Mikes on the inspection pit. There he found the 3100 with 40 lb. of steam on her gage, a clinkered fire and a work report which, if compiled with, would mean a recondition job. The 3044 offered some possibilities. Her fire was good, the work report only complained of a stiff reverse bar and the engine riding hard due to the spring rigging not being equalized properly. But she needed, besides a full tank of water, about three-fourths of a tank of coal. The 4390 was overdue for a monthly inspection form, so that was out. Realizing that a stiff reverse bar and the hard riding qualities of the engine were brain children of a complaining hoghead, Joe prompty dismissed these defects from his mind and proceeded to grab a hostler, an electrician and an oiler from the ready track force, spotted the 3044 alongside of the 3100 and transferred enough coal by hand to get by the road foreman of engines. By this time the yardmaster had spotted a couple of carloads of coal on the tipple, so the coaling situation was cleared up.

Engineer Ray Quinn was sliding down the hand rail of the 4420 as Joe approached the engine on his way back to the roundhouse.

"I've been an engineer round these parts for 16 years, Joe Cummings, but I ain't never had a hog that's as hard to handle and make time with as this old pill," blurted out Quinn.

"You mean that you've run an engine for the past 16 years," replied Joe with a contemptuous grin on his face. "That don't make you an engineer."

"Well, if this old wreck ain't got her valves squared up before morning, I'll go see the old man before I take her out again," yelled the hoghead as Joe rushed past toward the turntable.

EXPERIENCE had taught Cummings that there were more chronic complainers among the engineers around Riverdale than there were nuts in the storehouse. Ray Quinn, needless to say, had never consistently made time on any engine. Dan Foster, however, could take the same engine out on the next trip and make time. Ray's favorite alibi was that the valves needed "squaring up." Buck Rice never took out an engine on which he didn't report the reverse bar "handles hard" unless, of course, the engine was equipped with a power reverse. With some enginemen the brakes were never any good; with others, the sanders were partly stopped up. Yet these same engines were frequently handled by other engineers who made excellent runs but had no complaints regarding mechanical conditions.

Within the past year the roundhouse force at Riverdale had been reduced about 60 per cent, yet the despatchments had only dropped about 27 per cent. During

the past 60 days, however, the despatchments were running about 30 per cent higher than they were a year ago. With no increase in the mechanical force it was usually difficult to keep sufficient power available to handle the trains as fast as the chief despatcher would call them.

When 10 o'clock rolled around Joe was still in the "hole." The regular Mikados and Mallets were either on the ready track, already despatched or were getting up steam in the roundhouse. Seven of the eight extras were well under way and in sight. By using the "protect" passenger engine on one of the World's Fair excursion trains Joe was only one Mikado and one Pacific short for the calls till midnight. A 'Mike' due in on the Highball and a Pacific on the "Red Comet," if OK, would relieve the situation greatly. Six Mallets were due in before 3 o'clock with the empty coal cars and with only five regularly scheduled coal trains after midnight. Well, things started to look much brighter around Riverdale.

On his way to the inspection pit to look over the inbound engines Joe's attention was attracted by a yell in the vicinity of the ash pit. Arriving there he found that a hostler, mistaking a hanking squirt hose for a hand-rail, had gracefully slid down into the ash pit. He was fished out unceremoniously, wet but little the worse for his experience.

Excepting a report by the fireman that the apron was low and that the fire door would not open wide enough, the 5816 off the Red Comet was in fairly good shape for the second World's Fair excursion. A couple of tank-truck spring shims would raise the tender sufficiently to overcome the low apron and a few minor adjustments by a machinist on the Butterfly fire doors would make the passenger assignment complete.

The 2976 was pulling into the yard with the Highball as the 5816 was getting her supplies on the ready track so Joe did a marathon toward the inbound pit only to find upon his arrival that the right cylinder packing was entirely done for and the left link pin was galled in the front end of the eccentric rod. Not another Mike was available at Riverdale.

Stalling off the chief despatcher was about as easy as getting a day off each month to spend at home with the family, yet Joe was successful in having him set back the call for 12:45. Heading the 2976 toward the ash pit to have the fire cleaned, he proceeded toward the roundhouse to prepare a stall for her and to be on hand for the change of roundhouse forces at 11 p. m.

MATERIAL requisitions which had been prepared in advance of immediate requirements by the storekeeper were being held in abeyance in the general storekeeper's office, with the result that many items which were required for use in making repairs to engines in the shop were not available. In many cases this made it necessary to rob a part from one engine in order to release another. While the master mechanic was probably aware of the fact that such methods were being employed, it is doubtful whether or not full realization of the additional labor involved to do this with a reduced force was given as much consideration as it deserved. Such items as packing, bushings, engine-truck cellars, air-brake parts, stoker and headlight generator parts, as well as many more that could be mentioned, were being robbed from one engine in order to keep up repairs on another. It was this predicament that confronted Joe when he wanted a set of metallic cylinder packing and a link pin for the 2976. Among the stored engines on the dead line at Riverdale was the 2907, so he sent one of the three third-shift machinists to rob these parts, instructing him to "make it snappy" so as to get the parts back to the roundhouse in time to apply them before 12:30 a. m. The machinist was not very long in acquainting Joe with the fact that the valve motion had already been stripped from the 2907. There was nothing left to do but to secure a pin of another size and turn it down to fit. By 12:45 this had been accomplished, but by the time the 2976 arrived in the yard a delay of 35 min. had to be accepted by the roundhouse, chargeable to "engine late from shop."

IT was 2 a. m. when Joe found time to slip over to the railroad Y for his midnight lunch. It was usually between 1:30 and 2 when he took his place at the counter and gave in his order of eggs, bacon and home fried—sometimes a piece of pie—but always a cup of black coffee. The coffee was not for the purpose of keeping Joe awake either.

"Telephone, Joe," yelled the night Y clerk as he pushed the 'phone down the counter to where Joe was sitting.

"Grab an electrician and meet No. 3 at Riverdale station and take a headlight bulb with you," snapped the chief despatcher, "you've got 6 min. to make it."

"Hold up my order," moaned Joe as he did a marathon toward the storeroom to secure the bulb. There was no electrician assigned to the third shift tonight, it being his "regular night off" on the 40-hr. week working schedule, so Joe made up his mind then and there that this was a job for the night roundhouse foreman. No. 3 was pulling into the station as Joe arrived and it was only a matter of minutes before the new bulb was put in.

Returning to the Y, Joe succeeded in finishing his midnight lunch about 2:30, then headed for the inspection pit to see what the situation at that end of the terminal looked like.

By cleaning the fires, giving them a full tank of coal and water three Mallets would soon be ready for the roundhouse for a few minor adjustments, lubrication and supplies. The 909 was foaming badly and was reported as "pounding" in her main boxes. The 964 had failed for steam on the inbound trip and the inspector's report disclosed that the right front driver tire on No. 1 engine was condemned by the 15/16-in. condemning-limit gage. The 933 had not yet arrived in the yard, but Joe reflected that this was her first trip out since she was turned out of the back shop and there couldn't be much wrong with her. He was two Mallets short for the calls already scheduled and he had hoped to leave at least one hot engine on the ready track for the day foreman. Now he was fortunate if he was able to take care of his own schedules. The 964 was out of the picture, so he sent the 909 to the ash pit to have her fire cleaned and the boiler blown down. The pound in the boxes would have to wait until the next trip. He was still short one Mallet.

Back at the roundhouse Joe assigned the available force to work on the three engines required for the night's schedules and grabbed the lone boilermaker and sent him to the fire-up track with instructions to get busy on the 909's boiler. A boiler full of properly treated water and a fresh tank of the same water would overcome the foaming.

WHILE waiting at the inspection pit for the last of the inbound Mallets to arrive, Joe had his first chance to reflect on matters other than those that had demanded his attention throughout the night. His relief days, for instance, were few and far between since the last reduction had been made in the supervisory force about 15 months ago. Where he formerly had been allowed two nights off each month, this had been reduced

to only one. Vacations, it seemed, were a forgotten reward as far as roundhouse foremen were concerned. While a few of the men on the superintendent's staff were permitted to enjoy their annual two weeks' vacation, this privilege was denied those foremen whose jobs it was necessary to fill in their absence due to the additional expense involved. Joe had spoken to the master mechanic about a few days off during the summer months so that he could spend some time with his family on a trip to the seashore, but was told that any foreman who was fortunate enough to have a job during these times should be satisfied with his one day off each month and not try to run up additional expenses on his department. He had a job all right, a job that kept him around Riverdale from 12 to 15 hours each night, seven nights a week and thirty days each month. He merely worked, ate when he got a chance, and spent the balance of his time trying to sleep in the front room of his cottage with the blinds drawn to keep the sunlight out of his eyes. Such was the life for Joe Cummings, or for that matter to any other night roundhouse foreman.

At 4:40 a. m. the 933 came in on the inspection pit. The tank brakes had been sticking and the six tender wheels were beating a steady staccato on the rails before she came to a stop in front of the inspector's shanty. Except for leaky throttle and a clinkered fire, she was as good as the day when she was turned out of the back shop. Joe Cummings had his own ideas about these flat tank wheels and was inwardly jubilant that nothing else except a leaky throttle stood in the way of completing his line-up of scheduled power before his relief showed up at 6 a. m. He instructed the hostler to take her to the ash pit, clean the fire and place her in stall 17 so that the throttle could be repaired and the tank wheels taken care of.

By grinding the treads of the wrought steel tender wheels with a portable grinder for a distance of about 6 in. on each side of the flat spot, Joe anticipated correcting this trouble in such a way that not even the riding condition of the tank would be affected. He had resorted to this method on several occasions, especially on Mallet power, but had not advertised the fact to the enginemen.

It was 5:15 when Joe, after another round of the house, started for the office to call the chief despatcher to see what else, if anything, was happening on the railroad.

STANDING in the open doorway, he focused his eyes on the mountains across the river. The first rays of the sun were coming through the clouds. The day gave every promise of being as sultry as the previous one, making sleep more difficult.

Straightening up the pile of work reports that reposed on the general foreman's desk and contemplating things in general before scraping the grease from his arms and hands, Joe was interrupted by a thundering crash, a sound of breaking glass, then stillness from the direction of stall 17 in the house. One look was enough; the 933 had gone out by herself for fresh air through the outside wall of the house and was now draped with broken glass and bricks.

By 7:45 a. m. Joe finally managed to slip into his "other" clothes and start for home and his breakfast. Anticipating a call from the master mechanic to show up for an investigation about 3 p. m., he was giving serious thought as to whether he ever would show up around Riverdale again, although down in his heart he knew that he would.

When he arrived home he found his wife still waiting in the kitchen, having kept his breakfast as warm as could possibly be expected under the circumstances.

"How'd things go last night, Joe?" she asked as she hurriedly opened a couple of eggs and added them to the already simmering bacon in the pan on the stove.

"Swell," replied Joe, but before he could add anything his brother-in-law, Tom Campbell, who was a hoghead running the "river local" out of Riverdale, blew in and exploded:

"Pretty damned soft for you roundhouse guys sticking around home where it's cool these hot days, while us engineers has got to work like hell to get mileage out of a damned old boiler that's ready for the scrap pile. I sure will be glad when the Brotherhood puts through that 6-hr. day——"

As Joe started operating on the bacon and eggs he wondered idly what excuse for "not steaming" would appear on Tom's next work report.

Rubber-Lined Valve For Corrosive Substances

THE B. F. Goodrich Company, Akron, Ohio, has recently placed on the market a rubber-lined valve of simple design, known as the Vulcalock valve. This valve may be lined with any of the standard Goodrich Acidseal rubber compounds, either hard or soft, depending upon the conditions of service. The action of the valve does not depend upon a flexible diaphragm. A resilient rounded disk, which snaps over a circular plate at the lower end of the valve stem, provides a seal when brought into contact with a molded rubber-covered seat. Both the disk and the ring are inexpensive and easily replaceable parts. The Acidseal lining in these valves is bonded to the metal parts by a special process. Corrosive or abrasive materials in passing

The Vulcalock valve may be changed from an angle to straight-way by reversing the base

through the valve come into contact only with rubber especially designed to resist deteriorating action. The design of the valves is such that the flow through them is practically in a straight line, adapting them to fairly high-pressure work and abrasive service. On sizes up to and including 6 in. there is no restriction of flow through the seat ring. The valve is constructed in such a manner that it may be quickly changed from a straight way to an angle valve, or vice versa, by removing the

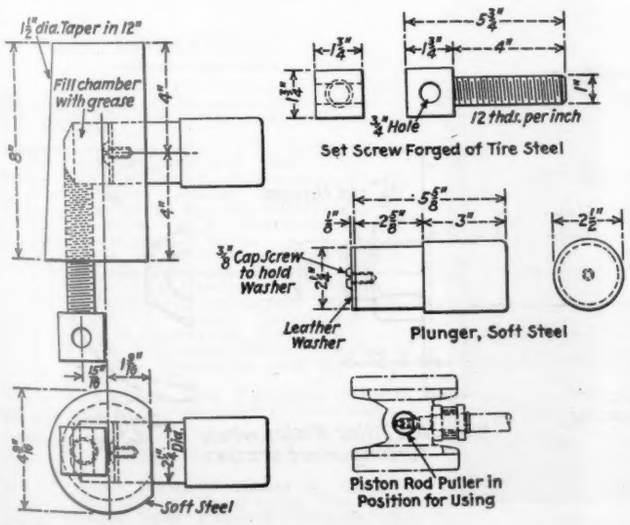
body bolts and reversing the lower section of the body.

The body is constructed of cast iron designed to withstand working pressures up to 150 lb. per sq in. The operating screw and thread bushing are of bronze cast into the iron yoke. There is no torsional stress on the stem either in opening or closing the valve and no rotary motion of the stem through the stuffing box which contributes to longer packing life. The stuffing box is cast integral with the upper section of the body, no bonnet being used, permitting positive alinement of the disk. When the valve is in the wide open position the back of the resilient disk provides a seal to the stuffing box which can be repacked while the valve is under pressure.

Piston-Rod Puller

A PISTON-rod puller which was developed some years ago at the El Dorado (Ark.) enginehouse of the Chicago, Rock Island & Pacific and subsequently used with satisfactory results at a number of points on this road is shown in the illustration. It consists of a soft-steel plug machined with a taper of 1½ in. in 12 in. to fit the wrist pin hole in the crosshead. One side of this plug is chamfered and drilled at the center to make a close fit on the 2¼-in. soft-steel plunger, the enlarged end of which bears against the end of the piston rod. It will be noted that the inner end of this plunger is provided with a leather washer held in place by a ⅜-in. cap screw in order to provide a packing or grease retainer which will prevent the escape of grease, even under heavy pressure.

The soft steel plug is provided with a small grease chamber formed by an extension of the plunger cylinder. A 1-in. hole drilled and tapped from one end parallel to the center line of the plug gives access to this grease chamber from the outside. Outward pressure against the plunger and piston rod is obtained by tightening a square-head, 1-in. screw against the grease in the grease chamber. As much leverage, and consequently as much pressure as needed, can be exerted by using a round steel bar of the required length inserted through the hole in the square head of the screw. The method of applying and using this piston-rod puller is clearly shown in the illustration.

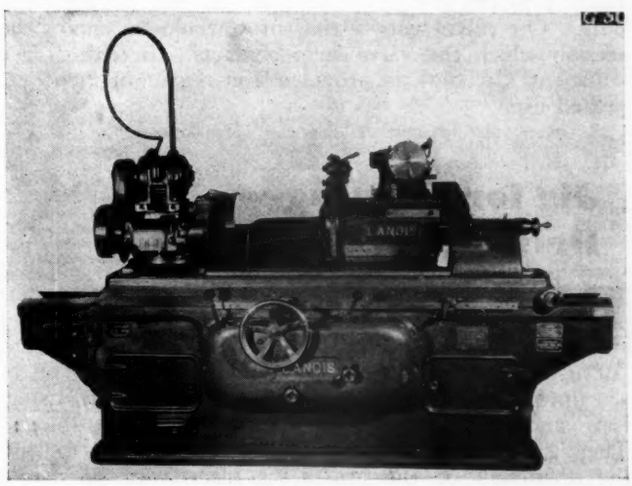


Piston-rod puller developed and used on the Rock Island

Hydraulic Universal Grinder

THE Landis Tool Company, Waynesboro, Pa., has recently announced a 14-in. type C hydraulic universal grinder which has been designed to fulfill requirements for a universal type of grinder adapted as well to manufacturing use on production jobs.

In this machine the weight has been distributed throughout the design in such a manner that strength, rigidity and wearing area have been placed where most needed, such as on large diameter spindles, oversize swivel platens and larger slides and ways. The wheel base is a heavy rigid casting with large spindles driven at the end by multiple V-belts. Babbitt-lined steel-backed bearings are used. Filtered oil supplied under forced feed by a pump driven by the spindle furnishes adequate lubrication to the bearings. An exclusive feature with this machine is the double-cylinder type hydraulic-table



Landis 14-in. universal grinder with hydraulic drive

traversing mechanism which assures smoothness of table traverse and reversal at all speeds and permits an almost infinite number of table speeds. This enables the operator to select a combination of work and table speeds best suited to the particular job being ground.

The head stock is fully universal and may be swivelled as much as 90 deg. for face grinding. The same is true of the wheel base. The standard equipment on this machine includes an anti-friction-bearing internal grinding fixture, a chuck for internal and face grinding, automatic hydraulic wheel-feed mechanism, center rest, and stationary and traveling cutter-tooth rests. Special equipment, such as rotary magnetic chucks, may be supplied.

This machine may be had in 14-in. swing only and in three lengths; namely, 36 in., 48 in. and 72 in. The net weight of the 36-in. size is 7,650 lb., the 48-in., 8,450 lb., without motors, and the 72-in. machine, 10,100 lb. The work drive is supplied with a ¾-hp. motor, the pump drive with a 1-hp. motor and a 5-hp. motor on the wheel drive. All of the motors are of the constant speed type and are dynamically balanced.

CHESAPEAKE & OHIO GAS WELL AT HUNTINGTON, W. VA.—A well drilled by the Chesapeake & Ohio in Huntington, W. Va., for fuel supply for its shop is estimated to have a capacity of 50,000 cu. ft. of gas daily. The production of this well, together with that of another well previously drilled, will be sufficient to meet the shops' fuel needs. The first well produces about 500,000 ft. of gas daily.

Carboloy Tips on Valve Stems and Seats

THE Carboloy Company, Inc., Detroit, Mich., has recently issued a bulletin relating to the use of Carboloy cemented carbide as a wear resistant insert on valve stems and seats, particularly on hydraulic valve stems and seats, such as are used in hydraulic presses, pumps, rams, etc., which are subject to such high abrasion and pressure that frequent replacements are necessary to insure accurate pressure control. By applying Carboloy to the tips of these stems and to the seats at their wearing points it is said that accurate pressure control is provided over long periods of uninterrupted use, resulting in a reduction in maintenance expense and replacement costs.

The Carboloy is applied to the valve stems and seats by brazing a small piece or blank to the section of the shank which is subject to wear. On a valve stem, Carboloy replaces the steel point at the end of the stem only. On valve seats a ring of Carboloy occupies the section which the valve stem contacts. In either case sufficient Carboloy is provided for regrinding and repeated use.

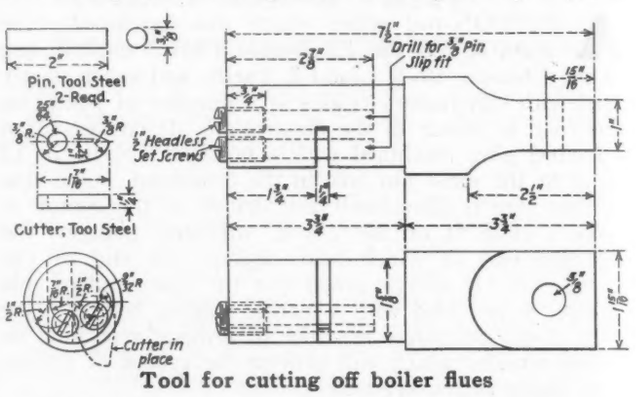
Jig for Turning Driving-Box Brasses

DRIVING-box brasses are most conveniently machined in a boring mill or vertical turret lathe, and the jig illustrated has proved unusually satisfactory for use when turning the outer diameters. The jig is set upright and bolted to the face of the mill, using four anchor bolts through the $\frac{3}{16}$-in. holes shown. Then a disc guide plate, made in various sizes to suit the diameters of the brasses is placed on the 3-in.-diameter shaft which is rigidly bolted and keyed to the center of the base plate. Guide lines are cut on the surface of the base plate to assist in centering the brass.

In operation, the brass is forced against the guide plate and held in the desired position by tightening the $2\frac{1}{2}$-in. standard thread nut against the upper guide plate which is also held against turning by a $\frac{1}{2}$-in. square key in an extended keyway. Four $\frac{5}{8}$-in. set screws in the upper plate are then tightened and further assist in holding the brass securely. These upper disc plates also are made in various sizes to suit different brasses, and filler plates are used under the $2\frac{1}{2}$-in. nut when necessitated by the turning of short brasses.

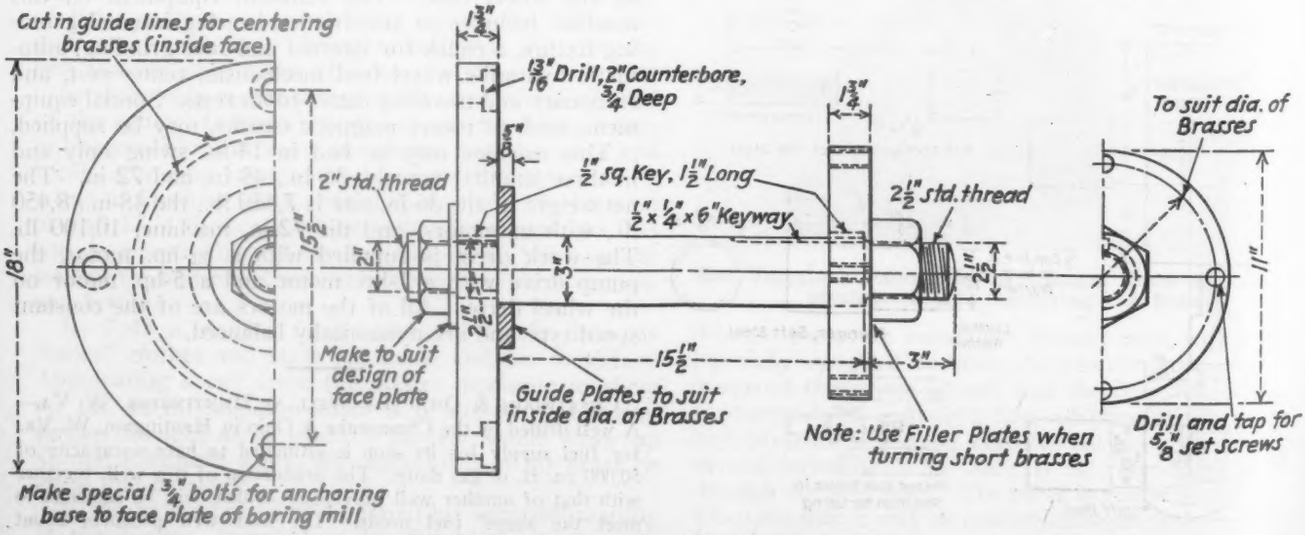
Flue Cutter

A FLUE cutter of the same general design as commonly used but incorporating certain dimension and proportions which greatly increase its efficiency, is shown in the illustration. It consists of a soft-steel body with a square shank for driving purposes, and a slot in the cylindrical portion designed to receive a special cutter made of tool steel to the shape and dimensions illustrated. This cutter is pivoted on a $\frac{3}{8}$-in. tool-steel pin, 2 in. long and held in place by a $\frac{1}{2}$-in. headless set screw. An additional positioning pin of the same size is also inserted as shown, being held by a similar headless set screw.



Tool for cutting off boiler flues

This tool is used for cutting off flues at the flue sheet. The flue cutter is bolted to a universal knuckle joint which is connected to a drive shaft operated by an air motor. The flue cutter is placed in the flue so that the shoulder on the cutter butts against the end of the flue. When power is applied the flue cutter rotates to the right, letting the cutting tool drop out of the slot to the cutting position. When the power is reversed the cutting tools drop back into the slot so that the cutter can be removed and placed in the next flue.


Cut in guide lines for centering brasses (inside face)
13/16" Drill, 2" Counterbore, ¾" Deep
2" std. thread
½" sq. Key, 1½" Long
½" x ¼" x 6" Keyway
2½" std. thread
To suit dia. of Brasses
18"
15½"
3"
Make to suit design of face plate
Guide Plates to suit inside dia. of Brasses
Note: Use Filler Plates when turning short brasses
Drill and tap for ⅝" set screws
Make special ¾" bolts for anchoring base to face plate of boring mill

Efficient jig for turning driving-box brasses

Among the Clubs and Associations

EASTERN CAR FOREMAN'S ASSOCIATION.—Over 200 railroad and supply men from the New York and New Haven districts attended the outing of the Eastern Car Foreman's Association which was held on July 20 at the Racebrook Country Club, New Haven, Conn. Golf, quoits and bridge were the principal events. The winners of the golf tournament were: Low gross (no class)—E. D. Searle, American Arch Company, Inc., and W. R. Gellatly, Pittsburgh. Low gross (Class A)—J. J. Pelley, president, New York, New Haven & Hartford, and C. Jarden, Sherwin-Williams Company. Low net—C. F. Monroe, New York; E. M. Harshbarger, SKF Industries, Inc., and W. C. Clingan, SKF Industries, Inc. Low gross (Class B)—C. E. Bryant, Jr., Johns-Manville Company, and H. M. Dewart, Central Vermont. Low net—B. Brown, Superheater Company, and N. T. McKee, Superheater Company. Low gross (Class C)—G. J. Martin, Equipment Specialties Company, and E. B. Perry, New York, New Haven & Hartford. Low net—W. C. Smith, New York, New Haven & Hartford, and G. W. Hayden, Magnus Company. The kickers' handicap was won by C. P. Greene, Galena Oil Company, and F. W. Gregory, Magnus Company. In the golfers' putting contest A. W. Fuller, American Brake Shoe Company, and W. K. Krepps, Crucible Steel Company, were the winners. F. J. Wall, vice-president, New York, New Haven & Hartford, and H. F. Coston, Central of New Jersey, were the winners in the non-golfers' putting contest. The prizes for quoits were won by G. W. Ditmore, Delaware & Hudson; T. P. O'Brian, O. M. Edwards Company, and John Schlintz, Sherwin-Williams Company. The bridge prizes were received by H. N. Ransom, Waugh Gould Company; R. R. Paradies, Beckwith-Chandler Company; B. P. Flory, New York, Ontario & Western, and R. Jenkins, Nathan Manufacturing Company.

Directory

The following list gives names of secretaries, dates of next or regular meetings and places of meeting of mechanical associations and railroad clubs:

AIR-BRAKE ASSOCIATION.—T. L. Burton, Room 2205, 150 Broadway, New York.

ALLIED RAILWAY SUPPLY ASSOCIATION.—F. W. Venton, Crane Company, Chicago.

AMERICAN RAILWAY ASSOCIATION.—Division V.—MECHANICAL.—V. R. Hawthorne, 59 East Van Buren street, Chicago.

DIVISION V.—EQUIPMENT PAINTING SECTION.—V. R. Hawthorne, Chicago.

DIVISION VI.—PURCHASES AND STORES.—W. J. Farrell, 30 Vesey street, New York.

DIVISION I.—SAFETY SECTION.—J. C. Caviston, 30 Vesey street, New York.

DIVISION VIII.—CAR SERVICE DIVISION.—C. A. Buch, Seventeenth and H streets, Washington, D. C.

AMERICAN RAILWAY TOOL FOREMEN'S ASSOCIATION.—G. G. Macina, 11402 Calumet avenue, Chicago.

AMERICAN SOCIETY OF MECHANICAL ENGINEERS.—Calvin W. Rice, 29 W. Thirty-ninth street, New York.

RAILROAD DIVISION.—Marion B. Richardson, Room 332, 30 Church street, New York.

MACHINE SHOP PRACTICE DIVISION.—R. E. W. Harrison, 6373 Beechmont avenue, Mt. Washington, Cincinnati, Ohio.

MATERIALS HANDLING DIVISION.—M. W. Potts, Alvey-Ferguson Company, 1440 Broadway, New York.

OIL AND GAS POWER DIVISION.—Edgar J. Kates, 1350 Broadway, New York.

FUELS DIVISION.—W. G. Christy, Department of Health Regulation, Court House, Jersey City, N. J.

CANADIAN RAILWAY CLUB.—C. R. Crook, 2276 Wilson avenue, Montreal, Que. Regular meetings, second Monday of each month except in June, July and August at Windsor Hotel, Montreal, Que.

CAR DEPARTMENT OFFICERS ASSOCIATION.—A. S. Sternberg, master car builder, Belt Railway of Chicago.

CAR FOREMEN'S ASSOCIATION OF CHICAGO.—G. K. Oliver, 2514 West Fifty-fifth street, Chicago. Regular meetings, second Monday in each month except June, July and August, Auditorium Hotel, Chicago, Ill.

CAR FOREMEN'S ASSOCIATION OF OMAHA, Council Bluffs and South Omaha Interchange.—Geo. Kriegler, car foreman, Chicago, Burlington & Quincy, Sixteenth avenue and Sixth street, Council Bluffs, Iowa. Regular meetings, second Thursday of each month at Council Bluffs.

CENTRAL RAILWAY CLUB OF BUFFALO.—M. D. Reed, Room 1817, Hotel Statler, Buffalo, N. Y. Regular meeting, second Thursday each month, except June, July and August, at Hotel Statler, Buffalo.

CLEVELAND RAILWAY CLUB.—F. B. Frericks, 14416 Alder avenue, Cleveland, Ohio. Meeting second Monday each month, except June, July and August, at the Auditorium Hotel, East Sixth and St. Clair avenue, Cleveland.

EASTERN CAR FOREMEN'S ASSOCIATION.—E. L. Brown, care of the Baltimore & Ohio, Staten Island, N. Y. Regular meetings, fourth Friday of each month, except June, July, August and September.

INDIANAPOLIS CAR INSPECTION ASSOCIATION.—R. A. Singleton, 822 Big Four building, Indianapolis, Ind. Regular meetings first Monday of each month, except July, August and September, at Hotel Severin, Indianapolis, at 7 p. m. Noon-day luncheon, 12:15 p. m. for Executive Committee and men interested in the car department.

INTERNATIONAL RAILROAD MASTER BLACKSMITH'S ASSOCIATION.—W. J. Mayer, Michigan Central, 2347 Clark avenue, Detroit, Mich.

INTERNATIONAL RAILWAY FUEL ASSOCIATION.—T. D. Smith, 1660 Old Colony building, Chicago.

INTERNATIONAL RAILWAY GENERAL FOREMEN'S ASSOCIATION.—William Hall, 1061 W. Wabasha street, Winona, Minn.

MASTER BOILERMAKER'S ASSOCIATION.—A. F. Stiglmeier, secretary, 29 Parkwood street, Albany, N. Y.

NEW ENGLAND RAILROAD CLUB.—W. E. Cade, Jr., 683 Atlantic avenue, Boston, Mass. Regular meeting, second Tuesday in each month, excepting June, July, August and September, Hotel Statler, Boston.

NEW YORK RAILROAD CLUB.—D. W. Pye, Room 527, 30 Church street, New York. Meetings, third Friday in each month, except June, July and August, at 29 West Thirty-ninth street, New York.

NORTHWEST CAR MEN'S ASSOCIATION.—E. N. Myers, chief interchange inspector, Minnesota Transfer Railway, St. Paul, Minn. Meeting first Monday each month, except June, July and August, at Minnesota Transfer Y. M. C. A. Gymnasium building, St. Paul.

PACIFIC RAILWAY CLUB.—W. S. Wollner, P. O. Box 3275, San Francisco, Cal. Regular meetings, second Thursday of each month in San Francisco and Oakland, Cal., alternately.

RAILWAY CAR MEN'S CLUB OF PEORIA AND PEKIN.—C. L. Roberts, R. F. D. 5, Peoria, Ill.

RAILWAY CLUB OF PITTSBURGH.—J. D. Conway, 1841 Oliver building, Pittsburgh, Pa. Regular meeting fourth Thursday in month, except June, July and August, Ft. Pitt Hotel, Pittsburgh, Pa.

RAILWAY FIRE PROTECTION ASSOCIATION.—R. R. Hackett, Baltimore & Ohio, Baltimore, Md. Annual meeting October 17-18, Hotel Stevens, Chicago.

RAILWAY SUPPLY MANUFACTURERS' ASSOCIATION.—J. D. Conway, 1841 Oliver building, Pittsburgh, Pa. Meets with Mechanical Division and Purchases and Stores Division, American Railway Association.

SOUTHERN AND SOUTHWESTERN RAILWAY CLUB.—A. T. Miller, P. O. Box 1205, Atlanta, Ga. Regular meetings third Thursday in January, March, May, July, September and November. Annual meeting, third Thursday in November, Ansley Hotel, Atlanta, Ga.

SUPPLY MEN'S ASSOCIATION.—E. H. Hancock, treasurer, Louisville Varnish Company, Louisville, Ky. Meets with Equipment Painting Section, Mechanical Division American Railway Association.

TORONTO RAILWAY CLUB.—N. A. Walford, district supervisor car service, Canadian National, Toronto, Ont. Meetings first Friday of each month except June, July and August.

TRAVELING ENGINEER'S ASSOCIATION.—W. O. Thompson, 1177 East Ninety-eighth street, Cleveland, Ohio.

WESTERN RAILWAY CLUB.—J. H. Nash, 1101 Peoples Gas building, Chicago. Regular meetings third Monday in each month except June, July, August and September.

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Twin coach model equipped with Firestone pneumatic rail tires

NEWS

THE CUDAHY PACKING COMPANY has ordered 200 car sets of underframe material from the Pullman Car & Manufacturing Corporation.

THE SHAWINIGAN PRODUCTS CORPORATION, Shawinigan Falls, Canada, has ordered three aluminum tank cars of 8,000-gallon capacity, from the General American Transportation Corporation. These cars will be used to haul glacial acetic acid used in the manufacture of long-fiber rayon.

THE CHICAGO GREAT WESTERN is to install the following machine tools in its shops at Oelwein, Iowa, to replace obsolete machinery which is not suitable for work on modern, heavy locomotive equipment:

1 Locomotive driving wheel crank pin and double quartering machine
1 Special 38-in. stroke high-duty draw-cut shaper
1 18-in. by 8-ft. geared head engine lathe
1 24-in. by 14-ft. geared head engine lathe
1 36-in. by 16-ft. geared head engine lathe
1 800-ton 96-in. inclined type driving wheel press

THE BALTIMORE & OHIO has given an order to the York Ice Machinery Corporation for air-conditioning equipment for 20 passenger cars. These cars, comprising sleepers, chair cars, reclining seat cars, and coaches are to be used in the B. & O's. air-conditioned service to the Century of Progress Fair at Chicago. The equipment has been installed at the B. & O. shops at Baltimore, Md., and Washington, Ind. The York Ice Machinery Corporation has already furnished equipment for air conditioning on 142 other B. & O. cars.

CLASS I RAILROADS of the United States in the first five months of 1933 placed in service 1,249 new freight cars, according to the Car Service Division of the American Railway Association. In the same period last year, 1,671 new freight cars were placed in service. The railroads on June 1 had 1,205 new freight cars on order compared with 2,534 on the same day last year. The railroads placed one locomotive in service in the first five months this year compared with 22 in the same period in 1932. New locomotives on order on June 1 this year totaled one compared with 18 on the same day last year.

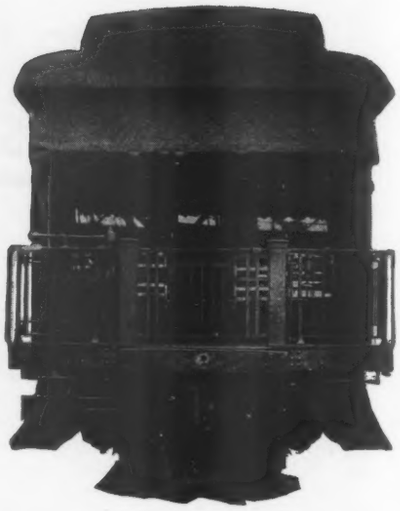
Burlington Locomotive Boiler Explodes

THE ENGINEMAN AND FIREMAN on the locomotive of the Ak-Sar-Ben, Chicago-Lincoln train of the Chicago, Burlington & Quincy, were killed and several persons were injured when the locomotive boiler exploded as the train was pulling into the Union Station at Omaha, Neb., on July 18. A station porter was severely scalded and died in the hospital. The force of the explosion damaged several sheds and a foot bridge.

Air-Conditioned Trains Bring Business to B. & O.

AIR-CONDITIONED passenger trains have done more to bring back passenger business to the Baltimore & Ohio than any other factor, according to W. B. Calloway, passenger traffic manager of that road. "Especially is this true of long-distance travel from New York, Philadelphia, Baltimore and Washington to Chicago and St. Louis," Mr. Calloway said. "Because so many people are going to Chicago this summer to see A Century of Progress Exposition, long-distance passenger business has picked up generally, but it becomes more and more apparent that persons going there prefer to travel on an air-conditioned train if possible.

"Nearly every day the entire berth space in the Capitol Limited of this road, which runs between New York and Chicago, has been taken up. To take care of this, arrangements have been made to operate this train in three sections twice a week, Tuesdays and Saturdays, for Chicago."



The "George Washington"

ACCORDING to an article in the July 22 Railway Age, the revenues of the George Washington, the first completely air-conditioned train on the Chesapeake & Ohio, were approximately 25 per cent greater than in the preceding 12 months during which this service was not air conditioned. This increase in traffic came at a time when the revenue of other trains was showing a decrease of from 25 to 30 per cent. Practically all of the additional business handled on the George Washington was new to the C. & O., and a check made among the passengers carried on all of the air-conditioned trains showed that a great many of the passengers were either people who had never ridden on the C. & O. or people who had not ridden on it for 15 or 20 years —since it went into eclipse as a passenger carrier during the war. The train is in service between Washington and Cincinnati, with through cars to New York, Chicago, St. Louis and Louisville.

Many Railroads Increase Car and Locomotive Repair Programs

Reports from 26 roads show closed shops reopening and others increasing schedules—Many men affected in both locomotive and car departments

THE STEADY increase in freight movement which has been taking place since the beginning of recovery from the banking moratorium in March and the heavy increase in passenger traffic to and from Chicago since the opening of the Century of Progress Exposition have created increasing demands for railway equipment. The result has been a widespread increase in equipment maintenance programs. Shop hours have been increased and additional men have been employed, both for heavy and light repairs. The facts concerning the expansions of maintenance programs during the past two months on 27 railroads are set forth in the following paragraphs.

Alton Railroad.—On June 26 the working time of the 330 employees in the Bloomington locomotive repair shop was increased from four to five days per week. Sixty-five additional men were ordered to return to work on Monday, June 10.

Atchison, Topeka & Santa Fe.—On July 1 the working time was increased from three to four days per week in the locomotive repair shops at La Junta, Colo., employing 171 men; Albuquerque, N. M., employing 377 men, and San Bernardino, Cal., 485 men. The working time for both the car and locomotive forces at Cleburne, Tex., was increased from two to three days per week; 176 men are employed in the locomotive shop and 211 in the car shop at that point.

Baltimore & Ohio.—Beginning June 26, three hundred and thirty men went to work in the Mount Clare locomotive repair shop and 200 car men were called back to work for light repairs on freight equipment at various points on the system.

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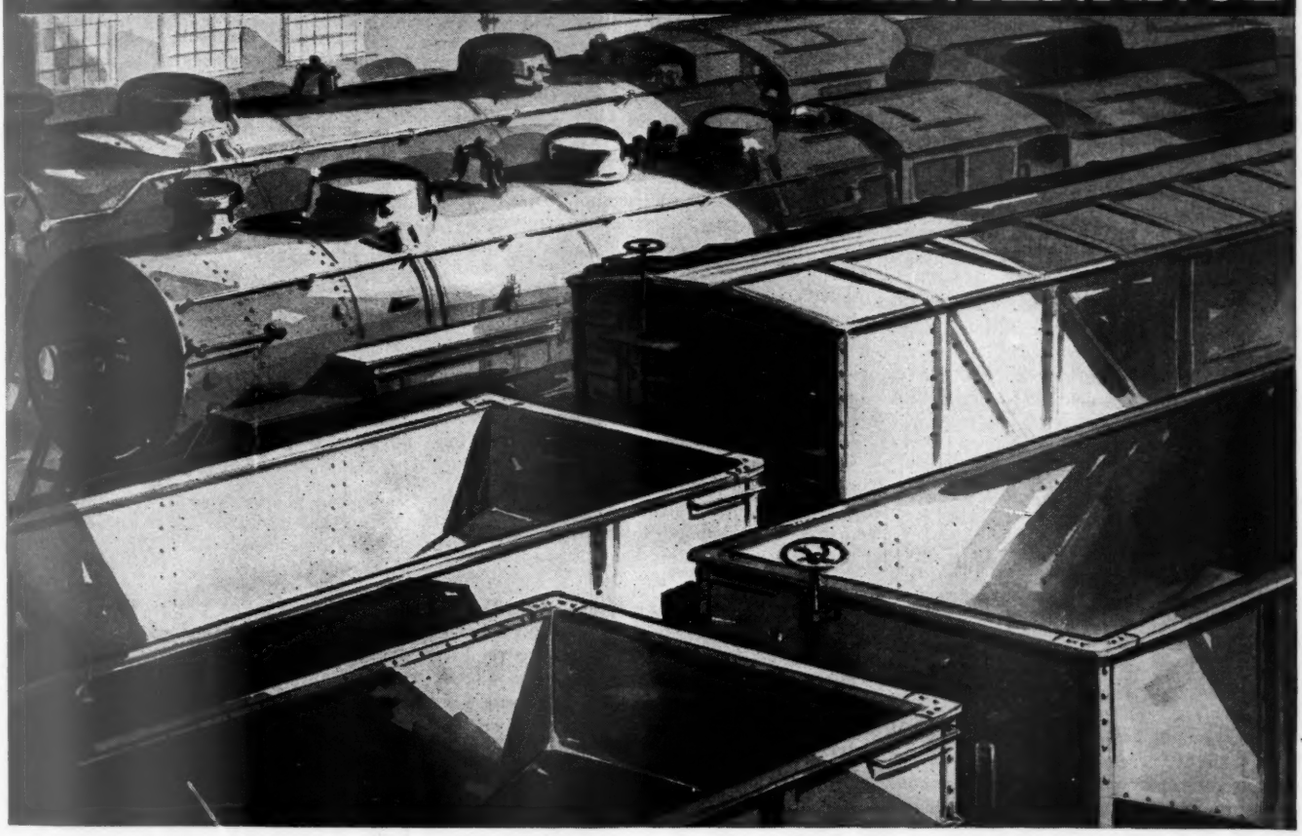
REPAIR WITH MODERN MATERIALS AND REDUCE FUTURE MAINTENANCE



Deferred maintenance is steadily growing by millions of dollars. It cannot be avoided much longer. » » But its ultimate cost can be kept to a minimum by use of modern materials that reduce wear, breakage and the inroads of rust and corrosion. » » In repairing freight cars, use Toncan Iron sheets and thus obtain an added protection against rust and corrosion that will lower future maintenance. » » Wear-resisting steels; alloy steels of greater toughness and higher tensile strength; steels that withstand the higher stresses of modern motive power—such materials should be used for replacements. » » These and many other special alloy irons and steels have been developed by metallurgists of Republic Steel Corporation to help you keep down maintenance expense. Make full use of them in your repair program.

Toncan Iron Boiler Tubes, Pipe, Plates, Culverts, Rivets, Staybolts, Tender Plates and Firebox Sheets • Sheets and Strip for special railroad purposes • Agathon Alloy Steels for Locomotive Parts • Agathon Engine Bolt Steel • Agathon Iron for pins and bushings • Agathon Staybolt Iron • Climax Steel Staybolts • Upson Bolts and Nuts • Track Material, Maney Guard Rail Assemblies • Enduro Stainless Steel for dining car equipment, for refrigeration cars and for firebox sheets • Agathon Nickel Forging Steel.

The Birdsboro Steel Foundry & Machine Company of Birdsboro, Pa. has manufactured and is prepared to supply under license, Toncan Copper Molybdenum Iron castings for locomotives.

CENTRAL ALLOY DIVISION, MASSILLON, OHIO

AGATHON STEELS

REPUBLIC STEEL CORPORATION

GENERAL OFFICES YOUNGSTOWN, OHIO

TONCAN IRON

Boston & Maine.—A repair program calling for an expenditure of approximately $400,000 will provide employment at Concord, N. H., for about 200 freight-car repairmen who have been practically idle for the past two years. The work, which calls for the rebuilding of 500 gondola coal cars of 50 tons' capacity, will start sometime in September, just as soon as the large amount of repair material can be purchased, assembled and classified. Approximately six to eight cars will be put through each day, operating on a five-day-week basis. This will provide about 14 or 15 weeks' employment for the entire freight-car repair force. On August 1, the Concord passenger-car shops reopened with a three-quarter force, staggered to work three-quarters time. This provides employment for about 220 men.

Central of Georgia.—Since June 1 the employees in the locomotive and car shops at Macon, Ga., have worked 45 hours instead of 32 hours per week. Employees at the Savannah coach shops have been working 45 hours per week as compared to 25.

Chesapeake & Ohio.—Running-repair locomotive and car forces have been increased by approximately 100 men.

Chicago & Eastern Illinois.—The locomotive repair shop at Danville, Ill., was closed last February, but was reopened in May and now employs 274 men; this is the normal force for the present volume of business. The car-repair forces are being maintained on a basis commensurate with the present volume of business.

Chicago & North Western.—There has been a slight increase in the forces at the various car-repair points. If business continues to increase it is anticipated that it will be necessary to add on August 1 a total of 400 men in the locomotive-repair departments of the Chicago & North Western and the Chicago, St. Paul, Minneapolis & Omaha.

Chicago, Milwaukee, St. Paul & Pacific.—The July payrolls for the locomotive and car-repair departments will be approximately seven per cent greater than in May.

Elgin, Joliet & Eastern.—Since May 1 the forces in the locomotive and car departments at Joliet, Ill., have been increased approximately 300, while about 150 have been added to the forces at Gary, Ind.

Erie Railroad.—Beginning July 1, the schedule for the locomotive shops at Hornell, N. Y., and Meadville, Pa., has been stepped up from 8 to 18 days per month. Prior to June 1 the car repair shops at Port Jervis, N. Y., Dunmore, Pa., and Huntington, Ind., worked 8 days per month. During the month of June the schedule at Port Jervis and Huntington was increased to 15 days per month, and beginning July 1 all the above shops have been placed on an 18-day per month schedule. Compared with the 8-day schedule, this represents an increase of 125 per cent in man-hours; 1,700 employees will be benefited.

Grand Trunk Western.—The working time has been increased at the Battle Creek, Mich., locomotive shops and the Port Huron, Mich., car shops.

Great Northern.—On Monday, July 10, the shops were opened at Hillyard, Wash., employing 235 men; St. Cloud, Minn., 156 men; and both the locomotive and car shops at St. Paul, Minn., employing 457 men.

Illinois Central.—The working forces have been increased by approximately 150 in the locomotive department and 265 in the car department.

Lehigh Valley.—A 30 per cent rise in business is increasing the working schedule of the shops from three days a week to four days a week. For more than a year up to July the shopmen had worked only two days a week.

Louisville & Nashville.—During the past 60 days increases in the shop forces have been authorized as follows: Locomotive department, Louisville, Ky., 153; Corbin, Ky., 51; DeCoursey, Ky., 13; Radnor, Tenn., 15; Seibert, Ala., 44. Car department, Louisville, Ky., 40; Corbin, Ky., 78; DeCoursey, Ky., 35; and Boyles, Ala., 66.

Missouri-Kansas-Texas Lines.—Since April approximately 800 employees have been put to work in the shops at Parsons, Kan., Waco, Texas, and Sedalia, Mo. The locomotive and passenger-car repair programs so far this year have been greatly in excess of those for all of last year. The management is hopeful that increased business will necessitate the continuance of this repair program.

New York Central Lines (including the P. & L. E. and I. H. B.).—The locomotive and car maintenance forces were at a minimum in March, 1933; during that month eight locomotive repair shops operated a total of 93 days, with 2,844 men, or an average of 11.6 days per shop. In July, nine locomotive shops operated a total of 140 days, an average of approximately 16 days per shop, and employing a total of 4,080 men. In the month of March three freight car repair shops worked a total of 15 days, or an average of five days per shop, 291 men being employed. In July four shops operated a total of 78 days, or an average of a little more than 19 days per shop, 1,448 men being employed. Two passenger car repair shops worked a total of 20 days in March, or an average of 10 days each, 367 men being employed. In July, three passenger car repair shops operated a total of 53 days, or a little better than 17 days per shop, 822 men being employed. The total number of shops operating in March was therefore 13, as compared to 16 in July, and the number of employees has been increased from 3,502 to 6,350.

New York, Chicago & St. Louis.—Forces have been increased by approximately 50 men on running and light repairs of locomotives and cars.

Norfolk & Western.—On July 1 the working time of approximately 7,000 employees in all shops was increased from three to four days per week.

Pennsylvania Railroad.—The policy with the upturn in business is to immediately restore the maintenance program for both track and equipment. The locomotive repair program affects Altoona, Pa., and Columbus, Ohio, so far as class repairs are concerned, and for running repairs is generally distributed over all the enginehouses on the system. The class repair program on freight cars affects Altoona, Harrisburg and Pitcairn, Pa., and Terre Haute, Ind. Practically all division centers of light repair points are affected by the increase in light running repairs. An effort is being made to distribute the work over the system as much as possible.

Pere Marquette.—Locomotive and car light-repair forces have been increased by approximately 50 men.

Reading Company.—Three hundred and thirty-nine men have been added to the shops at Reading, St. Clair and Wayne Junction, Pa.

Rock Island Lines.—On July 5 the shops were opened at Silvis, Ill., Horton, Kan., and Shawnee, Okla. They will operate five days a week and include a working force of 1,140 men.

St. Louis Southwestern.—During the past month a substantial increase has been made in the freight car repair program.

Southern Pacific Company.—About June 1 the working week was increased from three to five days. The following shops were affected: Sacramento, Cal., locomotive department, 581 men, freight car department, 106 men, passenger car department, 294 men; Los Angeles, Cal., locomotive department, 706, freight car department, 157, passenger car department, 141; Bayshore, Cal., locomotive department, 356, freight car department, 218, passenger car department, 103. This order also included the freight car repair departments at Oakland, Cal., 153 men; Roseville, Cal., 51 men; Bakersfield, Cal., 25 men; Dunsmuir, Cal., 14 men; Klamath Falls, Ore., 14 men; Eugene, Ore., 33, and Taylor, Cal., 68 men.

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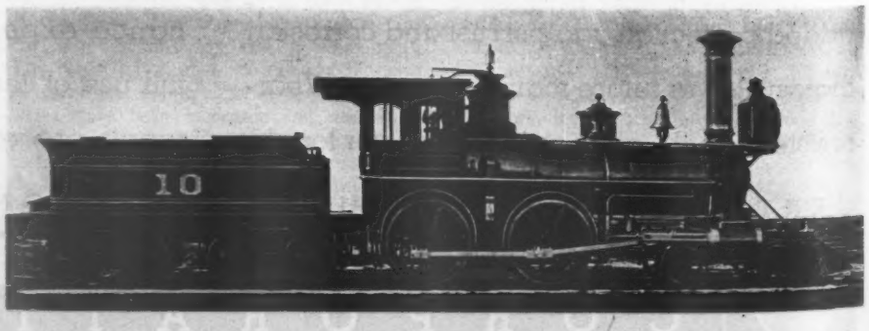


A locomotive built in 1879 for the Springfield Southern—It had driving wheels 55½ in. in diameter and cylinders 14 in. by 22 in.

DESIGN FOR LOWER MAINTENANCE

With the Help of the BOOSTER

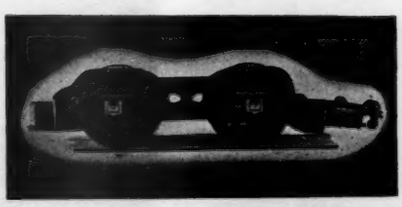
Because The Locomotive Booster is only used for a short period of the total running time, it saves substantially in locomotive maintenance.

The locomotive must be designed to supply the maximum power required to fulfill certain operating demands.

By incorporating The Locomotive Booster in the fundamental design of the locomotive, it is possible to obtain this desired maximum with smaller cylinders than would otherwise be the case.

The smaller cylinders mean lower locomotive maintenance since maintenance is approximately proportional to the power output.

Without The Locomotive Booster, larger cylinders must be used to secure the maximum power demand and then these larger cylinders must continue in service even when the power demand drops off at road speed.



THE LOCOMOTIVE BOOSTER

With The Locomotive Booster inoperative at road speed the smaller cylinders are ample to perform the required work.

Maintenance is therefore lower and, at the same time, 25,000 to 40,000 lbs. are saved in locomotive weight.

Design The Locomotive Booster as an integral part of your new power.

§

FRANKLIN RAILWAY SUPPLY COMPANY, INC.

NEW YORK CHICAGO MONTREAL

Supply Trade Notes

CHARLES W. T. STUART has been appointed manager of the Safety Car Heating & Lighting Company, with headquarters at Philadelphia, Pa. He will assume the duties relinquished by William L. Garland.

COL. O. F. HARVEY has been elected a vice-president of the American Car & Foundry Company, New York. Mr. Harvey had been an assistant secretary of the company since 1920.

H. C. THOMAS, assistant to general works manager at East Pittsburgh, Pa., of the Westinghouse Electric & Manufacturing Company, has been appointed sales manager of Micarta Products.

W. S. GAIN has been appointed district sales manager for the Buffalo territory by the Roller-Smith Company, New York. Mr. Gain's headquarters are at 416 Lafayette building, Buffalo, N. Y.

EDWARD J. BADE, who has been employed in the laboratory of the Dearborn Chemical Company, Chicago, has been promoted to sales representative to succeed A. C. HERRMANN, who has resigned to establish his own business.

E. E. ADAMS, vice-president of the Union Pacific System, with headquarters at Omaha, Neb., has been appointed vice-president of Pullman, Incorporated, in charge of the newly established research department especially concerned with development of transportation equipment.

W. L. GARLAND, vice-president, Safety Car Heating & Lighting Company, with headquarters at Philadelphia, Pa., resigned on July 1. Mr. Garland retires from a long and active business career to join his family in Arizona, where his son is engaged in the ranching business.

CHARLES W. HANFORD of the general sales department of the Ingersoll-Rand Company, New York, and for more than 20 years in the service of that company, died suddenly on July 11, at his home in New York, at the age of 59.

C. D. PETTIS, president of the Continental Brake Shoe & Equipment Company, died in New York City on July 9, after a short illness. Mr. Pettis had served in the car departments of the Southern Railway, the Illinois Central, the St. Louis-San Francisco and Swift & Company. He then became associated with C. M. Hewitt in the Featherstone Foundry & Machine Company, in Chicago, later being connected with the National Brake Shoe Company. He then went with the American Brake Shoe & Foundry Company and in 1922 at the time of his resignation he was vice-president and work manager. Mr. Pettis had been president of the Continental Brake Shoe & Equipment Company since its formation in 1926.

Personal Mention

Car Department

ARTHUR H. KEYS, general car foreman of the Pittsburgh Division of the Baltimore & Ohio at Glenwood, Pittsburgh, Pa., has been appointed district master car builder of the Pennsylvania-New York District of the B. & O., which comprises the former Buffalo & Susquehanna and the Buffalo, Rochester & Pittsburgh as well as the B. & O. main line from New Castle, Pa., to Cumberland, Md. Mr. Keys was born at Baltimore, Md., on September 21, 1898. He attended the public schools at Baltimore and Harrington, Del., and later enrolled in the night classes at the Carnegie Institute of Technology. He entered the service of the B. & O. as a messenger and file clerk in 1913 and in 1914 became a checker on the car-repair track at Glenwood. From 1915 until 1917 he was an M. C. B. billing clerk and in 1918 was car foreman at Youngstown, Ohio. Later in 1918 he was transferred to Baltimore as a joint car inspector. In 1919 he served first as a special

A. H. Keys

inspector for the district master mechanic at Baltimore and later as district safety appliance inspector. From 1922 until 1924 he was car foreman at Curtis Bay, Baltimore, and in the latter year was promoted to the position of general car foreman of the Baltimore Division. He was transferred as general car foreman to the Cumberland Division on September 1, 1928, and became general car foreman of the Pittsburgh Division on October 1, 1928. Mr. Keyes has been president of the International Railway General Foreman's Association since September, 1930.

Purchasing and Stores

A. C. MANN, vice-president in charge of purchasing of the Illinois Central, with headquarters at Chicago, has been appointed also purchasing agent.

Father Time and deterioration co-operate in creating future jobs